NATURE

No. 4203 SATURDAY, MAY 20, 1950 Vol. 165

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Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London
The annual subscription rate is £4 10 0, payable in advance, inland or Abroad

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TECHNOLOGY AND INTERNATIONAL RELATIONS

TWO years ago the lectures delivered at the twenty-fourth annual meeting of the Norman Wait Harris Memorial Foundation at Chicago dealt with the broad subject of technology and international relations*. The subject is examined, more particularly as it affects the basic elements of international policy, in the social field or that of defence, and recent developments in aviation, nuclear physics, fuel technology, broadcasting and mass communication, and steam and steel technology are considered. The inquiry and discussion follow the lines of an earlier report on "Technological Trends and their Social Implications" submitted in June 1937 to President Roosevelt by the National Resources Committee, and it also reflects to some extent the trend of thought of the late Lord Stamp as revealed in his presidential address to the British Association in 1936 and afterwards in his book, "The Science of Social Adjustment".

The report of the Harris Lectures, prepared by a scientific sub-committee headed by one of the lecturers, Prof. W. F. Ogburn, attempts to forecast the problems which the adoption and use of certain inventions would involve, and the lines of policy required to facilitate adjustment with the least possible suffering and loss. Running through the present lectures is rather a concern as to how best international policy can be concerted so as to avert the sterner threats to the very continuance of Western democracy and its tradition of freedom and respect for human personality that have developed particularly in the past five years. In this the lectures are linked with the central theme of Dr. Vannevar Bush's recent book, "Modern Arms and Free Men"†, and the trend of the recent debates in Parliament on defence. Neither book by itself does much towards answering the vital question as to how far the defence programme of Britain, and that of Western Europe, is adequate technically and psychologically to serve the major purpose of averting war. They do contribute substantially, however, towards formulating those questions to which public opinion has a right to insist that the Government shall give clear and full answers, so that a sound judgment may be formed.

The three lectures by Prof. Ogburn discuss first the extent to which technology affects the relative power of States, their geographical size and the pursuit of peace, particularly the bearing of the tendency for States to grow in size on the technology of war and the movements to preserve peace. The process of adjustment to new inventions is discussed more fully in his second lecture, where the importance of the secondary effects of any particular invention is emphasized. The ideas developed generally in these two lectures are illustrated in the third lecture, on

* Technology and International Relations. By Bernard Brodie, William T. R. Fox, Hornell Hart, Robert Leigh, William Fielding Ogburn, Abbott Payson Usher and Quincy Wright. Edited by William Fielding Ogburn. (Norman Wait Harris Memorial Foundation, Twenty-fourth Institute.) Pp. vii+202. (Chicago: University of Chicago Press; London: Cambridge University Press, 1949.) 22*s*. 6*d*. net.

† Modern Arms and Free Men: a Discussion of the Role of Science in Preserving Democracy. By Vannevar Bush. Pp. xi+300. (London: William Heinemann, Ltd., 1950.) 10*s*. 6*d*. net.

aviation and international relations, in which he brings out the need for a new policy which takes account of the changed situation. Isolationism is dead, and although aviation has increased the opportunities for contacts in peace-time between the peoples of different States, he believes the effect of aviation on national and international ideology is likely to be small, but is likely to strengthen the present trend towards nationalism. Nor is there any support for optimism in other lectures dealing with the effect on international relations of atomic energy, or the new inventions in printing, telegraphy, telephony, broadcasting, television and motion pictures which facilitate mass communication. Collectively, the latter are exerting a greater influence on popular attitudes—loyalty, understanding and prejudice—than the older intimate, quiet influence of groups meeting face to face. They may well offset the effects of increased foreign travel on international understanding and goodwill, even in the absence of the obstacles and hindrances to travel which have developed in the past thirty years. Like the application of atomic energy, they are essentially social implements that can do much either to build a peaceful happy world, or to accelerate a process of confusion and disintegration.

W. T. R. Fox's analysis of the effect of atomic energy leads him to emphasize the need for planned and rapid adaptation of the political organisation of the world. He recognizes that the primary obstacle is the unwillingness of Soviet Russia to co-operate, and that the first step towards international control is an inspection plan proof against evasion; internationalization of enforcement action must follow later. The first step would not banish war, but might make it possible for any war to be concluded before atomic destruction had been wrought on the great cities of all participants. Preventive war, indeed, looks even less attractive, and the utility of atomic weapons to achieve control of atomic energy may be doubted. Nevertheless, the contribution which national action can make requires re-examination, and Mr. Fox does not think that either total war or total peace is inevitable. Protracted bad relations may still be followed by a slow improvement.

What stands out most clearly from these lectures, and especially from those that follow on new techniques of war and national policies and on modern technology and world order, is the need for realism in considering international affairs.

The issues at stake have been put very clearly by Prof. F. Seitz in an address, "Physicists and the Cold War", given to the American Physical Society in New York last February (*Bull. Atomic Scientists*, March 1950). This address frankly analyses the reasons why physicists or other scientific men are reluctant to undertake defence research; he urges that it is not immoral to do our best to preserve the concept of tolerance in its broadest meaning and those ideals on which Western culture is based. All these ideals are now being threatened; further, Prof. Seitz is equally alive to the danger to freedom of communication which the secrecy regulations and security procedures themselves may represent. He recognizes that, in organising the defence of democracy, success will depend largely on our ability to keep alive those freedoms of thought and discussion without which democracy cannot function at its best. Some lectures on the social implications of modern science, given at a discussion arranged by the University of Michigan three years ago and since published in the *Annals of the American Academy of Political and Social Science*, make the same point. Prof. L. Wirth and Prof. W. Haber in particular, dealing with social science, security, freedom and modern technology, maintain that social science has an important contribution to make by seeking knowledge on better relations among men and the means for generating the will and the capacity for action directed to the achievement of a good society, and on the means by which the maximum security consistent with the preservation of essential liberties can be achieved.

Prof. H. Keniston, dealing further with the problem of values and the need for giving content to our concepts of freedom and human dignity, touches on that aspect of the problem with which Dr. Bush deals less satisfactorily in his recent book Dr. Bush's incursion into the social and political field in the latter part of his book has not the quality of his discussion of the technical issues. In fact, his preoccupation with the ideological conflict has led him to ignore the real political problems to which modern science gives rise in a democracy—those that arise out of a tendency for power to become concentrated in the hands of small oligarchies of different kinds. The enormous increase, relative and absolute, in the powers of government demands something more than faith and enthusiasm. The existence of these problems must be recognized, and wisdom and critical intelligence are required to solve them. Part of the problem of defence is indeed a study of the problem of government along such lines as Sir Ernest Barker has indicated, and is further illustrated by some of the current discussion on the Ministry of Defence in Great Britain.

All this is related to a second point that emerges from the lectures on technology and international relations. Success, whether in the 'cold' or a 'hot' war, depends on skilful leadership at least as much as on mere weight of man-power or industrial power. It would be very dangerous for a country to assume that future wars will be won on the assembly lines of its industrial plants. Science and technology will not stand still, and the increasing rate at which military technology is changing makes even bigger demands for sound judgment on the wise use of national resources, no matter how large they may be. A balance has to be struck at some level between the demands of defence and those other demands which must be met if a free people is to survive in time of peace.

Above all, it has to be remembered that the most economical defence policy and budget are those that ensure that war does not break out. These two books, like a subsequent article by H. W. Baldwin entitled "Strategy for Two Atomic Worlds" in *Foreign Affairs* of April, should do much to bring this point home to opinion in the United States, just as the defence debates and an admirable series of articles on defence

policy, with its plea for a high state of preparedness and an effective Ministry of Defence, in the *Economist* of April 1, 8 and 15, should do in Great Britain. Among the practical implications of such a policy, as pointed out broadly by B. Brodie in the lecture already noted, is the complete and over-riding priority for the provision of means of instant retaliation in kind against atomic attack.

Through these lectures there runs thus a realistic appreciation of what is at stake and what is involved. Acquiescence in the natural trend by which each major nation prepares for defence in rivalry with the others, and organises the lesser Powers in its region around it, is unlikely to avoid war; and even world federation, however desirable theoretically, might not prevent either atomic war or social revolution. The obstacles to federation might be surmounted if a sense of necessity favouring such a policy developed in all important countries; but even so the adoption of a formal federal constitution would leave grave difficulties for the process of transferring sufficient power to the federal body.

Here Quincy Wright lays the emphasis on the need for an act of faith. The schism between the Western World and the U.S.S.R. is due fundamentally to the absence of a common tradition and scale of values. Something more than a material basis is now required for world order. Even the values and tradition of science are to-day being flouted and discarded, and there can be no real *rapp ochement* until there is a spiritual basis for common understanding. That much, too, is recognized by Dr. Bush in a passage in which he challenges the conclusion that the world is doomed to be divided indefinitely into two camps, democratic and totalitarian. Democracy, he reminds us, involves habits of restraint and tolerance, and respect for the rights of other people; and reverence and understanding on such questions of values, which are only slowly acquired. There are countries where true democracy is impossible, and will be for a long time to come. We cannot, and should not, go far with such countries; but that does not exclude all possibility of friendship or of co-operation, if they are bent on peace.

Dr. Bush offers his book, indeed, as a contribution to discussion on the part science can play in the preservation of democracy. His unique experience and authority as chairman of the National Defense Research Committee in the United States, in spite of the limitations imposed by secrecy, lend exceptional interest to all that he has to say about the technical side of modern warfare and its implications. Nor is that interest weakened or the significance of his conclusions diminished by the disclosure, since his book was written, that the U.S.S.R. has been able to make an atom bomb, or that work on a hydrogen bomb is in hand. The majority of his readers must, it is true, accept his conclusions or reject them: for they will rarely have evidence by which to test the soundness of his judgment. Some will no doubt hold that experience in Great Britain of the receiving end of the guided missile suggests that Dr. Bush rather under-rates the importance of the rocket or the flying bomb, though he does admit that had such missiles been launched earlier unmolested they might have stopped the invasion of Europe. Nevertheless, even here Dr. Bush brings out the critical importance of sound judgment and the narrowness of the margin which will sometimes determine whether expenditure of national resources in a particular form of offence or defence is worth while. All the time he is illustrating the need for a clear public understanding of defence policy and of what it involves, and for public discussion to the maximum extent consistent with national security in the larger sense, as compared with the narrow sense of military security. He starts, indeed, from the military laboratory and seeks to trace the changes which the new techniques and dangers involve in our system of government if the values of a free society are to be preserved. Science itself, he reminds us, is conditioned by the political system that controls its operations and applications, and the philosophy by which men live determines in turn the form in which their governments are moulded. The nature of the democratic process and the achievements of science are, in fact, intimately intertwined; and one present danger to which Dr. Bush points is that, with too much secrecy frustrating the democratic process, and with science operating in a vacuum for security reasons, however sound, both will suffer.

The value of Dr. Bush's book lies essentially in its challenge to fundamental thought on such matters. It also conveys certain reliable and authoritative views on the present state of military science, and corrects the perspective of future warfare, particularly in respect of bombing and the atomic warfare danger. Dr. Bush avows his belief that, in land warfare at least, defence is regaining ascendancy over the attack, though at sea, with the improved new submarine, the present state of science favours attack.

Apart from that, and from the reservation with regard to the guided missile, much that Dr. Bush writes is reassuring, for all his reserve and the absence of any discussion, for example, of such matters as the bearing of the success of the Berlin air lift on the submarine and blockade problem. There the economic factor, on the increasing importance of which he rightly insists, may be decisive. His thesis that, in a democracy, development of weapons or any other product is likely to be more rapid and efficient because free men are co-operating in a spirit of give and take, without fear of punishment and without intrigue, may be challenged; nevertheless, his book illustrates the vital need for the fullest possible free discussion, in which men of science, economists and military men can come to speak the same language. Without unnecessarily supplying data to a potential enemy, there is a reasonably wide area of discussion which, neither in Great Britain nor in the United States, is being properly utilized in developing an informed public opinion.

Dr. Bush never conceals the difficulties which confront us in the task of making the democratic system work without abandoning, in the process of defence, the essential human freedoms on which it is founded. Whether he entirely resolves the qualms which a research worker may feel about the moral aspects of

defence research is another matter; but, as he rightly points out, this involves not just the consideration of the ways in which science affects the material things of man's existence, but also the way in which man's philosophy of life affects his interpretation—or misinterpretation—of the teachings of science. Scientific workers in difficulties on this point might well turn to the essay of Walter Bagehot on the metaphysical basis of toleration, which is as relevant to our present problem as to the time in which it was written seventy-five years ago.

Dr. Bush himself believes that the task of strengthening the institutions, including the military power, of the democracies must be based on a faith and a philosophy that will match those of totalitarian States, and in such a faith the belief in the freedom and dignity of man are factors which will help to build up a strength far beyond that which can be created and maintained by any regimented dictatorship. Here, however, Dr. Bush enters the political field and, as already noted, tends to over-simplify the issues.

It is almost obvious to suggest that the strength of the Western nations must always be exerted in the manner that will bring the greatest return. Exactly what that manner may be is a problem which should be occupying the urgent attention of our most alert and creative minds in the scientific and technological as well as in the political, economic and military spheres.

JAMES HUTTON (1726–97)

James Hutton, 1726–1797

Commemoration of the 150th Anniversary of his Death. (*Proc. Roy. Soc. Edin.*, B, 63, Pt. 4.) Pp. v+351–402+4 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1950.) 12*s.* 6*d.*

JAMES HUTTON, the founder of modern geology, was born and died in Edinburgh. In 1947, the one hundred and fiftieth anniversary of his death was commemorated in his native city and his native land. On November 3 of that year, a memorial tablet, appropriately cut from granite, was unveiled in Greyfriars Churchyard by the Lord Provost of Edinburgh[1], and, on the same day, Sir Edward Bailey delivered an address[2] on Hutton's work before the Royal Society of Edinburgh—the Society that in 1785 first heard the presentation of the immortal "Theory of the Earth". Sir Edward Bailey's address and other tributes laid before the Edinburgh Geological Society and the Geological Society of Glasgow, together with related contributions, now appear collected in a part of the *Proceedings of the Royal Society of Edinburgh*. The frontispiece of this commemoration is Raeburn's portrait of Hutton; among other fitting illustrations are one depicting the unveiling of the memorial tablet and another of Sligh Houses farmhouse in Berwickshire, where Hutton introduced the new husbandry. Two most excellent memorials to a great man of science are thus provided; the tribute would be completed by the reprinting of the "Theory", for there can exist at the present day no more than three dozen copies of this great classic of science.

In the first address, delivered by Dr. Murray Macgregor before the Geological Society of Glasgow, Hutton is presented as a great figure in a great age, taking his share in the intellectual renaissance of his country with such peers as David Hume, James Boswell, Adam Smith, Ferguson and Dugald Stewart the philosophers, Black the chemist, Adam the architect, and many another.

The second address, that by Sir Edward Bailey, considers three main topics selected from the "Theory of the Earth"—the igneous origin of granite and basalt, uniformitarianism and the importance of subaerial erosion. Besides giving a survey of his work as a geologist and an estimate of his stature as a man, Sir Edward summarizes Hutton's two-volume MS., "Principles of Agriculture", now in the custody of the Edinburgh Geological Society. In this work Hutton's treatment of agriculture fits in with his general proposition that the earth is a flawless machine.

Next follows a paper by Dr. G. W. Tyrrell dealing with Hutton's geological researches in Arran. Hutton considered that lovely island to be a field "proper to try the Theory of the Earth". He gave a summary of Arran geology that is astoundingly modern in some of its detail. As always, he insisted on the importance of the timing of geological events.

Mr. V. A. Eyles contributes a bibliographical study in which it is shown that the earliest publication of Hutton's "Theory" was in the form of an "Abstract" issued in 1785, the year of its reading.

The commemoration publication ends with a fascinating study by Dr. S. I. Tomkeieff of Hutton's contribution to the philosophy of geology reprinted from the *Transactions of the Edinburgh Geological Society*. Dr. Tomkeieff shows that there are two main aspects of Hutton's work, one known to all and concerned with scientific results, and a second, unrealized even by Playfair, Hutton's great interpreter, that constitutes the innermost core of the "Theory"—a core consistent with the philosophical concepts of Hutton's age. First, Hutton brought time into geology; he was profoundly interested in processes and not in matter—"material is the result of operations". He saw that there must be a balance between the destructive and constructive processes of the globe. In modern terms, his earth-machine was a cycle of magmatism, elevation of continents, folding, weathering, denudation, deposition and consolidation leading back to magmatism. This proposal of a cycle of changes in the earth led to the brilliant syntheses of Charles Lyell which, in turn, influenced the development of the modern theory of evolution by Darwin and others. To-day, it underlies the whole science of geology.

The second aspect of Hutton's "Theory", overlooked by the historians of science, was in keeping with the thought of his time. A fundamental pattern was manifest in microcosm and macrocosm. Hutton transferred the pattern in the organism to the earth as a whole; this, says Dr. Tomkeieff, is the real "Secret of Hutton". There is a hierarchy of individuals from minerals through plants and animals to man. The quintessence of Hutton's thought is presented in the following passage from the "Theory": "we are thus led to see a circulation in the matter of this globe, and a system of beautiful economy in the works of nature. This earth, like the body of an animal, is wasted at the same time that it is repaired." He saw the earth as an organic unity. H. H. READ

[1] Eyles, V. A., "James Hutton (1726–97) and Sir Charles Lyell (1797–1875)", *Nature*, **160**, 694 (1947).

[2] "James Hutton: Geologist and Agriculturist", *Nature*, **160**, 727 (1947).

UNIVERSITIES OF THE BRITISH COMMONWEALTH

The Yearbook of the Universities of the Commonwealth, 1949–50

Twenty-seventh issue. (Published for the Association of Universities of the British Commonwealth.) Pp. xxxi+1367. (London: G. Bell and Sons, Ltd., 1950.)

THE "Yearbook" was first published in 1914, and this twenty-seventh issue which now supersedes that of 1948 is once more a mine of information. It is published by the Association of Universities of the British Commonwealth, and one of the first things that it records is the change that took place in 1948 whereby at an extraordinary general meeting the Association was given its new name in place of the old Universities Bureau of the British Empire.

The book covers the university institutions of the British Commonwealth (and also, "for historical reasons", those of the Republic of Eire), and the information is compiled from official lists obtained in the first place from the relevant institutions. The subject-matter is made up of a separate section on each country, each section being prefaced by a general introduction which contains a short history of the growth of university education in that country. Short notes on general information are appended to each institution, and, for the more recently founded, these notes include a brief historical résumé. A large proportion of the text is taken up with lists of the staff on the faculties of the various institutions, and this probably forms the most useful part of the book as a work of reference (and is the one which no doubt requires the most attention in preparing successive issues). The value of such staff lists is considerably enhanced by a name index, in addition to an ordinary general index.

Since the previous issue of 1948, the Universities of Nottingham and Natal have received their charters, and the relevant details of these Universities have been published. The editor was unable to include details of the new University of Malaya, and it was not until the time of going to press that he received information regarding the new Universities of Poona and of Jammu and Kashmir.

The last part of the "Yearbook" consists of eight appendixes devoted to the following topics: (1) qualifications for admission to a first degree in the universities of Great Britain and Ireland; (2) the number of students from overseas in the universities and university colleges of Great Britain and Ireland; (3) postgraduate scholarships and grants for advanced study and research, tenable in the United Kingdom; (4) postgraduate scholarships and grants, etc., tenable outside the United Kingdom; (5) the composition of the Inter-University Council for Higher Education in the Colonies (which was created in 1946), and the terms of reference of the Council; (6) universities of the United States (a very brief outline); (7) details of four appointments for the study of Anglo-American relations; (8) university admission from 1951, as a result of the forthcoming introduction of the General Certificate of Education (this appendix is a supplement to (1)). Of these appendixes, (2) is mainly a statistical analysis of the distribution of overseas students in Great Britain, and it gives the interesting facts that there are 7,960 such students (4,311 from the Commonwealth) made up as follows: Europe, 2,003; Asia, 1,974; Africa, 1,844; America, 1,488; Australasia, 635; stateless, 16.

The editor states that it is hoped to publish future issues during the first quarter of each year. In welcoming this present issue, we trust that the normal difficulties of publication which beset such an enterprise—apart from the special difficulties of the present day—will not hinder this admirable endeavour.

THE ADRENAL GLAND IN MAMMALS

The Mammalian Adrenal Gland

By Geoffrey H. Bourne. Pp. vii+239+15 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 30*s.* net.

A FAVOURITE gambit of lecturers is to tell students that the amount of structural differentiation of the anterior part of the pituitary gland belies the organ's multiple functions. The position is rapidly becoming the same in the case of the adrenal. Dr. Bourne's attempt to enlarge our knowledge of the structure of the gland is therefore very timely. After an introductory chapter outlining the history of our knowledge of the subject, he takes the mammals in turn, and provides a statement about the structure of the adrenal in each of them. The observations on marsupials are mostly his own, whereas those which relate to the Eutheria are mainly a compilation of scanty statements that have appeared in the literature. The book ends with a chapter in which the author tries to derive some generalizations, and indulges in certain speculations. His main generalization is that the adrenals in most of the Eutheria are stable both in position and structure. In the marsupials they vary in both respects, while in the monotremes they are fairly constant in position but variable in structure.

None of these conclusions is very new. On other scores, too, the book leaves the reader unsatisfied. We are told, for example, that the right adrenal gland is immediately applied to the inferior vena cava in two species of marsupial, an anatomical arrangement which "makes it possible for the gland to secrete adrenalin instantaneously into the main blood stream without having to pass, as in most other mammals, along an adrenal vein. This should enable these animals to give a remarkably prompt response to any emergency." But the right adrenal vein is always very short, and it is very questionable whether the existence of, say, ¼ in. of venous channel would make the slightest difference to the speed of the organism's response to adrenalin. Dr. Bourne also seems confused when he considers the site of cellular proliferation in the cortex. One view is that new cells proliferate in each zone. Another is that they are added to the cortex by the division of cells between the glomerulosa and fasciculata, and that the new cells migrate inwards to the zona reticularis, where they die. Dr. Bourne starts by apparently favouring the first view, and ends by building speculations on the second.

But the real shortcoming of Dr. Bourne's book is that it is out of date. In a bibliography comprising 425 titles, only six deal with works as recent as 1940, four with 1941, six with each year 1942, 1943 and 1944, five with 1945 and three with 1946, while no subsequent year is mentioned at all. It contains no

references to recent, but already well-known, work on the nerve supply, vascular architecture, and histochemistry of the gland. In his preface, Dr. Bourne tells us that his book is part of a thesis he submitted for the degree of doctor of science in Australia in 1934. It is a pity that a book which certainly contains some useful information could not have been brought up to date before publication, nor orientated, at any rate partly, along modern lines as well as along the more traditional lines of comparative anatomy.

CALCULATING THE FLOW OF HEAT

Heat Conduction

With Engineering and Geological Applications. By Prof. Leonard R. Ingersoll, Otto J. Zobel and Alfred C. Ingersoll. (International Series in Pure and Applied Physics.) Pp. xii+278. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 24s.

IN contrast to the other two modes by which heat may be transferred, conduction has been the subject of much successful work by theorists as well as by experimentalists. To the former, the calculation of heat flow means the evaluation of the field of temperature in a homogeneous substance when either the temperature or the heat flow is given at each point on the boundaries. If, then, heat enters or leaves the substance by radiation or convection, the phenomenon is taken into account only in the boundary conditions.

The methods available for solving this boundary problem are varied; they include the use of the Fourier or the Laplace transform, which in many cases removes from consideration the time as an independent variable. In simpler cases, the solution may be obtained as the sum of an infinite series of the normal functions for the equation, these functions depending, of course, on the co-ordinates used for the space variables. Other solutions are obtained by the use of the Green's function, or by making use of the concept of sources and sinks, just as in hydrodynamics.

This book is best described as an introduction, but only an introduction, to the mathematical calculation of heat conduction, and with a marked bias towards the physics of the problem. The simpler methods among those mentioned above are described and illustrated; but the use of conformal transformations and of Laplace transforms is not mentioned, and no methods calling for advanced mathematics are used. The physical outlook makes the book very stimulating for those who have problems of this sort to solve in practice, but would probably be repellent to a mathematician. To him, an approximation to the solution of a problem which he cannot solve explicitly means an expression which differs from the solution by an amount to which he can set an upper limit. Here, he would find 'approximations' which consist in changing the boundary conditions. For example, instead of a boundary condition in which heat loss is proportional to temperature excess, a fictitious layer of material may be added, the boundary of which is not allowed to change in temperature. To the applied physicist, however, this treatment will appeal as an ingenious device for getting an approximate idea of the course of the temperature with time, when the problem as originally formulated could not be solved by the methods at his command.

The book treats separately the steady state, periodic regimes, and non-steady regimes, with 'linear' flow treated separately in each case because of the simplicity obtained when there is only one spatial co-ordinate. Numerical, graphical and analogical methods of solving the equation of heat conduction are considered, as well as formal solutions, and there is an interesting chapter on the formation of ice. The book should be useful to mathematicians who take up practical work, and to practical men themselves, though both should realize that there is more aid to be obtained from mathematics than is shown here.

J. H. AWBERY

ARCTIC EXPLORATION

To the Arctic!

The Story of Northern Exploration from Earliest Times to the Present. By Jeannette Mirsky. Pp. xxii+334+xviii+12 plates. (London and New York: Allan Wingate (Publishers), Ltd., 1949.) 21s. net.

IT is not easy—and perhaps ill-advised from prospects of popular acceptance—to write a history of polar exploration without a bias to the heroic, sentimental or patriotic. A mere catalogue of expeditions would make dull reading, and the most successful and least adventurous efforts are generally monotonous in their records. The epic of shipwreck, hunger and scurvy provides popular sensation; but very often these are signs of faulty organisation.

The author of this large work has not altogether escaped the longing for the picturesque, but gives it no undue prominence. She dwells fully on much American and Russian work and gives details of such ghastly failures as the Greely expedition of 1881–84 and De Long in the *Jeanette*. Nansen's crossing of Greenland, which marked a great advance in technique, rightly has full notice; but several later and more successful crossings, such as that of Lindsay, are omitted. Details of Russian work, including seventeenth- and eighteenth-century work in Arctic Siberia, and modern work in the same area, are welcome since they are rarely available to English readers. The long story of the Franklin search is well told, with due emphasis on Rae's work. The travelling methods of the men of the Hudson's Bay Co. are shown in violent contrast to the naval technique of those days. Nor do the Admiralty and the leader of its expeditions, especially Belcher, escape well-merited criticism, even if some of their journeys were marvels of grit and endurance. The work is full and accurate, and a chapter on Arctic aviation brings it well up to modern times.

Miss J. Mirsky does not claim to mention every expedition, for her compilation is no mere catalogue. Perhaps Glen's work in North East Land should have found a place, and Norwegian aerial surveys in Svalbard also merit notice. Mistakes are rare and trivial. Jan Mayen's peak has an unfamiliar title. Rae can scarcely be said to have tried a crossing of Greenland, and a distinguished Spitsbergen explorer is wrongly credited with a university chair. There are some good illustrations and adequate maps. The book is a great improvement on the first edition, published in 1934 as "To the North".

R. N. RUDMOSE BROWN

My Philosophy

And other Essays on the Moral and Political Problems of our Time. By Benedetto Croce. Selected by R. Klibansky, translated by E. F. Carritt. Pp. 240. (London: George Allen and Unwin, Ltd., 1949.) 15*s*. net.

BENEDETTO CROCE, the one Italian whom Mussolini dared not silence and who was impervious to bribes and blackmail, is now well over eighty; but many of the essays in this book have been written quite recently. One on "Liberalism and Democracy" (No. 11 of the series) was actually published during the Nazi occupation, though in a learned journal which officials of the Gestapo were not likely to read of their own accord.

Three fairly long essays come first: "My Philosophy", where Croce explains his debt to Hegel and his difference from him; "The Moral Problem of Our Time", which is the old problem of how to combine liberty and order; and "Why We Cannot Help Calling Ourselves Christians", an interesting avowal by a thinker who could never by any stretch be claimed as orthodox. The remaining thirty-four pieces are mostly short, some only a page or two. The bulk of them are political and, as might be expected, centre round the topic of liberty. Others deal with ethics and æsthetics, which for Croce are closely related subjects. Five are concerned with history and are the most difficult to follow. It is quite clear, though, that history for Croce is the product of the wills of human persons, not merely of impersonal forces or mass-movements. At the end are some pieces, headed "Various Thoughts", mostly quite short; the longest and most interesting is called "Soliloquy of an Old Philosopher". Here he comes back to his persistent theme, the interrelation of liberty and morality, and that, in spite of all setbacks in history, ideals are not extinguished. Perhaps it is meant to be Croce's valediction—one hopes not.

The translator has evidently done his work skilfully and carefully; but rather too many misprints have crept in. A. D. R.

Kungl. Skogshögskolans Skrifter: Nr. 2-3

Tillväxtprognoser vid Skogsindelning: Två Problem (Prognosis of Increment for Calculation of Cutting), av Sven Petrini; Simplified Deduction of some Statistical Formulæ, by Sven Petrini. Pp. 12+4. (Stockholm: Kungl. Skogshögskolan, 1949.) 1 kr.

TWO bulletins on statistics (Nos. 2 and 3), both by S. Petrini, have recently been published, bound together in one volume, by the Royal School of Forestry, Stockholm. In the first, the author discusses estimation of growth increments in forests, by extrapolation from knowledge of the growth that has taken place during past years. He points out the serious danger that biased estimation will result from the common practice of assuming a linear rate of increase. In the latter part of the paper, the bias produced by natural deaths among the trees is considered.

The formulæ considered in "Simplified Deduction of some Statistical Formulæ" are those for the standard deviations of sums and products of statistical variates. The derivation of the formulæ may be simple, and the results are in the main correct, but the theory on which they are made to rest is entirely unsound. The correct formula for the standard error of a weighted average is stated to be wrong, and is replaced by a formula which may easily be seen to be quite incorrect. It is surprising that faulty proofs and erroneous statements on questions of so elementary a character should be published in the official bulletin of an institution of high repute.

D. J. FINNEY

Gall Midges of Economic Importance

By Dr. H. F. Barnes. (Agricultural and Horticultural Series.) Vol. 6: Gall Midges of Miscellaneous Crops. Pp. 230+14 plates. (London: Crosby Lockwood and Son, Ltd., 1949.) 15*s*. net.

THE latest volume of Dr. H. F. Barnes's comprehensive series on the gall midges deals with those which infest such miscellaneous crops as bamboos, basket willows, plants which serve as the source of beverages, dyes, textile fibres, sugar, spices, rubber and insecticides, together with medicinal and culinary herbs. The most substantial section is that which describes the midges of basket willows, on which the author has already published much original work. As Mr. A. Roebuck points out in a characteristic foreword, Dr. Barnes maintains an admirable balance between the point of view of the entomologist and of the grower.

The interest and value of the book is greatly enhanced by the introductory notes on the character and uses of the divers crops. An appendix by Mr. H. C. H. Newton describes preliminary experiments in which it was shown that the midges which attack willows are repelled by their normal host plants if these are smeared with extracts from the 'immune' species of *Salix*, whereas there is no attraction to the immune species if these are smeared with extracts from susceptible varieties. As with earlier volumes, there are excellent indexes to the midges and the plants, and a general subject index. V. B. W.

Bird Portraits

A Book of Sketches and Paintings, with a Commentary. By J. C. Harrison. Pp. 119 (16 plates). (London: *Country Life*, Ltd., 1949.) 63*s*. net.

MR. J. C. HARRISON is well known as a skilled bird artist, and this volume of "Bird Portraits" from his brush and pencil will enhance his already considerable reputation. It includes some lovely pictures in colour and a number of pencil sketches. The latter are particularly fascinating; for example, the kingfisher plate, whereon this brilliant fisherman is shown in a variety of poses and caught in mid-dive. Although these pencil sketches are but black-and-white work, the artist has captured the effect of iridescent colour, and we feel the bird's flashing beauty emanating from the page.

The drawings of various ducks are also attractive, especially those of sheldrake and long-tailed duck. Mr. Harrison shows us the sheldrake from fluffy white-and-black ducklings to maturity, and has well caught the somewhat goose-like character of the species. His colour plate of five sheldrake rising from the sand-dunes, to fly out over the shore, towards the incoming waves of a quiet sea, is one of the most charming of his colour illustrations; indeed, it pleased me best of all.

This volume is, of course, a picture book; but the paintings and sketches are supplemented by interesting notes, in which the artist tells us of his experiences and observations when sketching in the field. In conclusion, it only remains to say that every lover of bird life will enjoy this volume. FRANCES PITT

BRITISH SCIENTIFIC INSTRUMENTS

PHYSICAL SOCIETY'S EXHIBITION

THE thirty-fourth annual exhibition of scientific instruments and apparatus organised by the Physical Society was held at the Imperial College of Science and Technology, South Kensington, during the period March 31–April 5. Owing to the increasing popularity and consequent overcrowding of the exhibition in previous years, the Exhibition Committee decided that on this occasion the exhibition should be open for five days and that admission should be by ticket only, to limit the number admitted in each session to manageable proportions. The system of ticket admission to evening sessions also proved very successful. On the five days during which the exhibition was open, a total of 13,500 were admitted. The modified admission arrangements and extension of the period of the exhibition had the desired effect of reducing the overcrowding, and visitors this year could inspect the exhibits in greater comfort than in previous years.

The general impression obtained in a tour of the exhibition was the high-class design and workmanship shown in British scientific instruments. In every field of physics first-class instruments are now available, often better in quality than similar instruments obtainable from other countries. The scientific instrument industry put up a very fine display and is to be warmly congratulated. It is unfortunate that not only the number of visitors attending the exhibition had to be restricted, but also the number of exhibitors and the number of exhibits. The floor space available at the Imperial College is limited and the accommodation for exhibits has reached 'saturation', with the result that a considerable number of firms were excluded this year from the exhibition. There is no immediate prospect of rectifying this unfortunate situation. The only alternative means of providing sufficient suitable accommodation would appear to be to hire a large hall such as those at Earl's Court and Olympia, but a 'charitable organisation' such as the Physical Society has no funds available for such a purpose.

In his opening remarks, the president of the Physical Society, Prof. S. Chapman, directed attention to the fact that by these annual exhibitions the Society seeks to fulfil one of its main functions, namely, the furtherance of new knowledge in the realm of physics. The physicist needs tools of greater and greater variety and precision to assist him in his researches, and in the exhibition were brought together the manufacturer of such instruments and the research worker seeking to know how and where to obtain the best instruments available.

The date of the exhibition this year coincided with that of the centenary celebrations of the Royal Meteorological Society. The Physical Society's president, Prof. S. Chapman, is also a distinguished fellow and past president of the Royal Meteorological Society. It was not inappropriate, therefore, that the Physical Society's exhibition should include items of interest to the Royal Meteorological Society also. Three of the four discourses delivered during the exhibition were of combined physical and meteorological interest, and in the exhibition a well-known scientific instrument firm (also celebrating its centenary) showed a good selection of meteorological instruments. The first discourse was given on March 31 by Prof. S. Chapman, on solar physics and the aurora polaris. During solar flares, corpuscular streams are emitted from the sun that give rise, if suitably directed towards the earth, to great magnetic storms and brilliant auroral displays. The earth's magnetic field deflects part of the solar matter entering it and guides it to high latitudes, where it enters the atmosphere nearly along the lines of magnetic force. The corpuscles penetrate the atmosphere down to heights of 100 km. approximately, and render the molecules constituting it luminous. The distribution, spectra and other characteristics of aurora borealis and aurora australis were described. Polar expeditions have made paintings and drawings of such displays, and colour films (copied from these paintings) were shown.

The second discourse was given on April 3 by Dr. W. D. Wright on "Colour Vision and Colour Television". This discourse, well illustrated by experimental demonstrations, dealt first with the fundamentals of colour vision, showing that any system of three-colour reproduction depends fundamentally on the possibility of matching a large range of colours by an additive mixture of red, green and blue lights in varying proportions. It was shown that the colour characteristics of the eye could also find a direct application to colour television—the eye being replaced, for example, by a three-channel cathode ray tube system having red, green and blue filters. Various methods were considered for the production and synthesis of separate red, green and blue pictures, their relative merits being determined by the extent to which picture brightness and definition could be sacrificed for colour—an interesting point was raised here, relating to the role of colour discrimination in visual perception. The third discourse (on April 4), by Dr. F. J. Scrase (Meteorological Office, representative of the Royal Meteorological Society), dealt with "Sounding the Upper Air". A historical survey was made of the methods of exploring the meteorological properties of the atmosphere up to great heights. Early experiments with manned balloons were followed, Dr. Scrase pointed out, by the development of recording instruments for use on kites and small sounding balloons. The more recent use of aircraft for 'met' observations has led to the development of special equipment for the accurate measurement of temperature and humidity at high levels. British work in the development and application of radio and radar techniques in meteorology was discussed in detail, and reference was made to recent measurements of wind and temperature at heights up to 30 km.

It had been arranged that Sir Robert Watson-Watt (president of the Royal Meteorological Society) should deliver the fourth discourse on April 5, his subject being "The Earth's Atmosphere", but a few days before the lecture he suggested that he would like to forgo giving his discourse in favour of Dr. V. J. Schaefer (General Electric Co., New York), who was visiting Great Britain to lecture at the centenary meetings of the Royal Meteorological Society. It was happily arranged, therefore, that Dr. Schaefer should deliver the fourth discourse, his subject being "Experiments with Cloudy Skies"; Sir Robert Watson-Watt was chairman at the lecture. Dr.

Schaefer described the formation of snow and ice crystals and clouds in the laboratory. In such laboratory experiments it is possible to recognize whether clouds are formed of ice crystals or of water drops. Various dusts such as ash, soils, etc., can act as nuclei for condensation of water at different temperatures, and silver iodide acts in this way at temperatures around 0° C. Experiments on 'seeding' with silver iodide have been carried out, and photographs show the tracks in which the cloud has been made to condense. In a large-scale experiment, an area of about 300 sq. miles had been cleared over New York when the surrounding country was overcast. Dr. Schaefer predicted that eventually it would be possible to do away with thunderstorms by dispersing or modifying the cloud structures before they reach their intense stages. The lecture was in the nature of a running commentary to a series of beautiful coloured photographs of ice and snow crystals, cloud formations and turbulence, and photographs taken above the clouds showing the effects of 'seeding' with silver iodide.

A feature of the exhibition which is of great importance is the craftsmanship competition, open to youths employed by firms and other organisations interested or concerned in the manufacture of scientific instruments. The interest in this competition is steadily increasing, and many of the exhibits revealed great skill and pride in craftsmanship. A hundred entries were received and the standard was extremely high. Some very fine examples of glass-blowing, mechanical construction, design and draughtsmanship were shown—such excellent work by youths of eighteen or thereabouts augurs well for the future of the scientific instrument industry. This section of the exhibition must not only be encouraged by the Physical Society but also by the scientific instrument industry and by government research organisations.

The splendid display of scientific instruments, research apparatus, etc., was provided by a hundred and thirty-six firms and research establishments. A very full description of the exhibits is given in the "Handbook of Scientific Instruments and Apparatus, 1950", issued by the Physical Society*. This handbook consequently serves as a valuable reference book of up-to-date information on physical apparatus and methods. It is a well-reproduced volume on art paper and well illustrated by a large number of half-tones and diagrams. It is of interest to note that, of the total number of exhibitors, nine were well-known firms of booksellers and publishers exhibiting scientific literature. The books on view formed an interesting collection of recent publications on physics, applied physics and engineering. An interesting 'line' shown by one firm of booksellers was scientific stationery, including "a comprehensive range of daily, weekly and monthly charts, logarithmic, 'Z' charts, polar graph, probability, circular percentage, reciprocal triple co-ordinate, time-table, planning, sectional sheets, etc.".

The following remarks relate to a few exhibits chosen almost at random from the impressive display at the exhibition. As is now almost customary, electronics permeates almost every aspect of physics—valves and cathode ray tubes find an almost universal application. There are still, however, a few branches of physics not requiring these relatively modern devices. This applies more particularly to the mechanical side. As an example of this, one exhibit displayed a wide variety of specialized tubing for precision instruments. The application of the Bourdon tube covers a wide range of instruments, including pressure and vacuum gauges and recorders, expansion-type thermometers with metallic systems, chronometric radio-sondes, etc. The same stand also had an interesting variety of metal capillary and multibore tube. The capillary tubing is used to transmit high pressures from the source to the instrument being used, and for various reasons the volume of the bore must be very small and the bore diameter accurate. In one example, special capillary tubing with a wire core (forming an annular space) is equivalent to an effective bore diameter of 0·003 in. accurately controlled to limits of ± 0·0005 in. There is a growing demand for metal capillary tubes containing more than one hole, required in gas and liquid ejector and heat exchanger research. Such multibore tubes can now be supplied with as many as fifty holes in a tube of outside diameter 0·5 in.

On the mechanical side again, there are signs of a steady improvement in vacuum pumps and gauges. Rotary vacuum pumps, suitable for backing pumps, were shown with a displacement of 7–8 litres/sec. and an ultimate vacuum of the order of a few thousandths of 1 mm. of mercury. Pumping speeds of 250 litres/sec. below a pressure of 10^{-4} mm. mercury can now be obtained by oil diffusion pumps. An interesting Admiralty exhibit demonstrated a novel type of mercury-vapour vacuum pump in which the vapour condenses on an amalgamated copper surface. Its speed characteristics are by this means brought up to the level of those of oil vapour pumps. In this exhibit supersonic flow of the jet (Mach number 2) was demonstrated by a high-frequency luminous discharge inside the pump, which showed a conical shock wave produced as the jet strikes the apex of a cone. A quartz fibre microbalance depending on the torsion of a horizontal 25 micron quartz fibre was exhibited. This has a maximum total load of about 1 gm. The maximum weight difference measurable by torsion is 2 mgm., and the sensitivity of the index fibre setting represents a weighing sensitivity of 10^{-8} gm. This extremely sensitive balance is used mainly in connexion with microchemistry, particularly of radioactive substances.

There is a considerable demand for industrial noise- and vibration-measuring instruments. With regard to the former, physicists are not yet agreed on the correct basis for design; but industrial firms continue to produce subjective and objective noise meters which temporarily serve a useful purpose. An interesting demonstration was shown of a 1-kW. moving-coil vibrator, designed for the electromagnetic excitation of vibrations from zero to 1,000 c./s. in large and complex structures such as aircraft, automobiles and small civil engineering structures. For the measurement and checking of audio-frequency apparatus such as amplifiers, filters, loudspeakers, transformers, etc., a portable audio-frequency response curve tracer was shown, the response curve being displayed on the calibrated surface of a long-afterglow cathode ray tube. The National Physical Laboratory exhibited a model illustrating its methods of absolute free-field calibration of standard microphones. Two independent methods have been used, the Rayleigh disk for frequencies up to 25,000 c./s., and the method of reciprocity for frequencies up to 100,000 c./s. The two methods show good agreement. Free-field

* Handbook of Scientific Instruments and Apparatus, 1950. Pp. xii + 266 + 68*A*. (Physical Society, 1 Lowther Gardens, London, S.W.7.)

acoustical measurements are usually carried out in absorbent rooms. The National Physical Laboratory exhibit also showed a model of apparatus in the form of a duct, with an absorbent termination which enables plane progressive waves to be set up over a range of low frequencies of 25–450 c./s., disturbances due to reflected waves and other causes being reduced to the order of 1 per cent.

A method for the dynamic measurement of the elastic constants of small metal crystals was demonstrated. A quartz crystal, acting as a transmitter, is mounted on a metal block, and a second crystal, acting as a receiver, on a similar block. The blocks are pressed into contact and the travel-time of a short train of mechanical waves passing from one block to the other is measured accurately, with and without the test specimen between the blocks. The difference of time gives the velocity of the waves in the specimen, and hence information about its elastic constants. An interesting demonstration of an industrial use of supersonics was a soldering iron for aluminium and its alloys. The 'bit', heated electrically in the usual way, is made to vibrate at supersonic frequency while the solder is being applied. The violent high-frequency agitation disrupts the tough oxide skin on the aluminium and allows normal 'tinning' to take place. The supersonic vibrations are excited by a magnetostriction oscillator which provides 50 watts of high-frequency power.

An optical exhibit, shown by the British Iron and Steel Research Association, demonstrated a particle-size meter for carbon in luminous flames. An interrupted parallel beam of ultra-violet light is incident on a region of a luminous flame, and the light scattered by the cloud of luminous carbon particles is detected by a photo-multiplier and measuring A.C. amplifier. When the wave-length of the ultra-violet light is comparable with the particle-size, the character of the scattering is strongly dependent on the particle-size. A well-known optical firm staged a fine display of spectrographs. One of these was fitted with operating desk and push-button control, all the interlinked adjustments being automatically actuated by an electric motor drive. An interesting application of electronics to optics was demonstrated in the moving image converter used as a quick-acting optical shutter, pulses as short as one microsecond being observable.

In the field of magnetism, a range of permanent magnet alloys was shown, special attention being directed to the newer alloys, 'Alcomax' III and IV, and to the most recent development of high-energy 'Alcomax' having oriented columnar crystal growth. A large adjustable permanent magnet of 'Ticonal' to illustrate how such magnets can be used to replace electromagnets was shown. One model designed for atomic research had a field which could be regulated between zero and 10,000 gauss. The Radar Research and Development Establishment demonstrated a magnetic fluid clutch which originated in the United States. It is based on the phenomenon that a suitable mixture of iron powder and oil can be relatively liquid under normal conditions and relatively solid when subjected to a magnetizing field. The torque which the iron–oil mixture can transmit is found to be an almost linear function of current in the magnetizing coil—a few watts can control several horse-power. The Hall effect in germanium has been utilized in a magnetic-field strength meter. A flake of germanium ($\frac{1}{8}$ in. × 0·1 in. × 0·015 in. thick) is mounted in a probe and is capable of measuring field-strengths in very small gaps; the various ranges of the instrument demonstrated covered 0 to 25,000 gauss. A further application of germanium is in crystal triodes, which are now manufactured in a more robust and controllable form. The germanium used in these instruments is obtained from flue dusts from British coal, which contains up to 0·001 per cent of germanium. In the United States it is obtained as a by-product of zinc refining.

In spite of the popularity of cathode ray oscillographs, it is gratifying to note that the Duddell oscillograph is still a 'best seller'. In the exhibit showing the latest models of this famous oscillograph were shown also a number of old Duddell instruments and photographs of historical interest—these included the original pencil drawings by Duddell to which the first instruments were made. (It will be recalled that one of the most honoured prizes awarded by the Physical Society is the Duddell Medal for meritorious work in the design of scientific instruments or the materials used in their construction.) The development of ferrites in recent years was exemplified in a number of exhibits showing manganese–zinc and nickel–zinc ferrites. The permeability and losses in these mixed ferrites depend on their exact composition and can be varied over a wide range. Extremely high frequencies (of the order 10^9) can be reached with only moderate losses (less than 10 per cent). Conductive ceramics are now available which are robust and resistant to thermal shock. By ranging the composition (of the metallic oxide mixture) and thermal treatment, resistors up to 0·1 megohm can be obtained with positive, negative or zero temperature cofficients. High-permittivity ceramics based on barium titanate provide dielectrics with a wide range of properties, one of particular interest being piezo-electric.

Space forbids more than mention of the very high-class 'general purpose' galvanometers on view at the exhibition. These combine robustness with short period and high sensitivity—qualities not often found together. The familiar 'Megger' insulation-testing instruments now cover a range up to 50,000 megohms—a remarkable achievement.

In the realm of atomics and nuclear physics a number of exhibits showed the now more or less familiar electronic counters, radiation monitors, etc. Other exhibits of this nature demonstrated the use of radioactive methods of measuring the thickness of strip materials, and a completely self-contained apparatus for the accurate measurement of radio-active isotopes; a range of isotope containers, 'lead castles', screening blocks and Geiger–Müller tubes were also displayed.

As befitting this particular exhibition which, as already mentioned, combined certain aspects of the activities of the Physical Society and the Royal Meteorological Society, a good display of meteorological instruments was on view: barometers, barographs, rain gauges, sunshine recorders, thermometers (including deep-sea type), hygrometers, earth temperature recorders, etc. The Telecommunications Research Establishment demonstrated a new radar-sonde. A balloon-borne transponder and a single ground station are used to measure wind speed and direction automatically up to slant ranges of 100 miles. Also, atmospheric pressure, temperature and relative humidity are measured at regular intervals during the ascent and descent of the transponder. The exhibits illustrated the techniques used, and experimental balloon-borne units were shown. Another radio exhibit demonstrated, with a 3-cm.

microwave model, the land–sea recovery effect that has been predicted and observed on wave-lengths of 4 m. and 100 m.

Obviously, it would be possible to describe more and more exhibits in this way; but the reader is recommended to consult the Handbook for further information. As usual, during the exhibition, an exhibitors' meeting was held to discuss ways and means of improving future exhibitions.

The exhibition was, like its predecessors, a great success, and a credit both to the scientific instrument industry and the Physical Society.

A. B. Wood

DISTRIBUTION OF BRITISH PLANTS

THE study of plant distribution is an especially suitable field for collaboration between amateur and professional botanists. The observations of the former can be organised to provide a mass of valuable records available for classification, plotting, and interpretation by those with wider knowledge and facilities. The subject was therefore particularly appropriate for a conference arranged by the Botanical Society of the British Isles, which has members resident in all parts of Great Britain. Under the title "Aims and Methods in the Study of the Distribution of British Plants" the conference was held in the Royal Horticultural Society's New Hall, Westminster, on March 31 and April 1, and was followed by a field meeting at Quendon, Essex, on April 2.

The methods introduced by H. C. Watson (1804–81) for recording the distribution of vascular plants in Britain have been continued and extended without fundamental change for three-quarters of a century. During this time there has been rapid advance in related studies, and the object of the conference was to bring together botanists interested in different aspects of the subject, to enable them to compare various methods of recording and plotting distribution, and to discuss the adequacy of these methods in relation to the aims of modern study. Special attention was directed to the Watsonian vice-county system as employed in Great Britain and alternative schemes in use abroad.

After a short introductory talk by the president, Mr. J. S. L. Gilmour, director of the Royal Horticultural Society's Gardens at Wisley, a paper on "The Study of Plant Distribution" was read by Mr. S. M. Walters (University of Cambridge). First, defining terms used to describe distribution, he gave a historical account of the study abroad and in the British Isles from the end of the eighteenth century (Willdenow, 1792) to date. In discussing the aims of the study of plant distribution and the methods employed, he emphasized the inevitable dependence generally of method upon aims, while acknowledging that much of the basic field-work—the collection of records—could be pursued for its own sake. The danger of this dependence lay in the fact that methods (for example, of cartographical representation) may be chosen to illustrate with false clarity some preconceived hypothesis.

Mr. Walters said that there seemed to be general agreement between plant geographers on the following points: (1) that climate (in the widest sense) is the primary factor in controlling distribution; (2) that soil factors are important but subsidiary to climate; (3) that great physiographic and climatic changes in the past have left their mark on present distribution; (4) that the relationship between environmental factors and plant distribution can never be reduced to simple cause and effect; (5) that every species has a definite tolerance-range with a genetic basis analogous to the genetic basis of morphological characters; (6) that the range of a plant is subject to continuous variation. The changes are sometimes rapid enough to be obvious, but more often so slow that they cannot easily be recorded. They are due to changes in the environment, the migration of species, and slow fundamental genetic changes within the species itself.

He directed attention to the discontinuity in range between east and west in the case of some British species, and suggested that *Veronica spicata*, an example of the Steppe element in the East Anglian flora, is conspecific with the western "*V. hybrida*", which is no more than an extreme ecotype. The interesting association of Continental, Alpine, and Arctic–Alpine species in Upper Teesdale may be relict in permanent open habitat by post-glacial survival. Such plants were more widespread in late Glacial times and became more restricted in range through the spread of closed forest and blanket bog. *Arenaria gothica*, *Veronica praecox* and *Scutellaria hastifolia* may be examples of additions to the British flora due to recent accidental long-range dispersal of seeds into open habitats. In conclusion, he appealed for autecological studies, cultivation experiments to ascertain the amount of ecotypic variation within species, careful recording of the spread of aliens, and studies of the ranges of segregates in critical groups.

Dr. D. H. Valentine (University of Durham) then discussed "Geographical Distribution and Isolation in some British Ecospecies". He selected ten pairs of allied species which have the same chromosome number and which are capable of forming moderately fertile hybrids (gradual ecospecies). These were: *Nuphar lutea*, *N. pumila*; *Viola hirta*, *V. odorata*; *Melandrium dioicum*, *M. album*; *Silene cucubalus*, *S. maritima*; *Geum urbanum*, *G. rivale*; *Epilobium hirsutum*, *E. parviflorum*; *Saxifraga umbrosa*, *S. geum*; *Primula vulgaris*, *P. elatior*; *Salix viminalis*, *S. caprea*; *Quercus robur*, *Q. petræa*. The effective mode of geographical, genetical or ecological isolation was assessed in each case, and then discussed against the background of the hypothesis that geographical isolation has been the essential prerequisite for the formation of these species.

He suggested that each pair of species had arisen from a single ancestral form and that primary geographical separation had led to morphological, genetical and ecological differences. When they were brought together later by climatic changes or the activities of man, their continued existence as separate species was dependent on whether the barriers mentioned were strong enough to prevent them from fusing into single polymorphic species. The evidence indicated that *Nuphar lutea* and *N. pumila* showed a tendency towards fusion and were dependent on geographical separation. In the other cases, morphological, genetical and ecological differences were sufficient to maintain them as separate species. He asked the Society to consider the production of a list of interspecific hybrids which occur in Britain on the lines of Focke's "Pflanzen-Mischlinge", which he had found extremely useful in work of this kind.

The conference then turned to consideration of the methods employed in recording plant distribution in

Britain. "The Watsonian Vice-county System" was described by J. E. Dandy (British Museum (Natural History)). He explained that Watson first introduced the term 'vice-county' in his work "Cybele Britannica" (1852), and, although for a time its use was restricted to the parts of those counties which were subdivided, it was later extended to cover all the 112 units into which Watson had divided England, Wales and Scotland. The great advantage of the system was that county boundaries were discernible in the field and known to all. The difficulty in its use was that county boundaries had changed, while for scientific purposes it was essential that they should remain as defined by Watson. Unfortunately, much research had been necessary to ascertain the precise boundaries he had in mind. The work was initiated by a joint committee of representatives of the Botanical Society of the British Isles (then the B.E.C.) and the Systematics Association (then the A.S.S.) held in 1939, and later continued by a sub-committee of the Association. A series of maps on the scale of 10 miles to 1 inch, based on maps supplied by the Ordnance Survey, is in preparation under the editorship of Mr. Dandy and is to be published by the Ray Society.

The next paper, on "The Watsonian Vice-county System in Practice", was read by Mr. J. E. Lousley (general secretary of the Botanical Society). After describing the ways in which the system has been employed for the arrangement of plant records in Great Britain, he examined the nature of the evidence on which the records were based. He showed that some of the entries were founded on unreliable sources, such as items ticked in catalogues by local botanists of varied standing, and advocated the citation of herbarium material as the basis of a scientific system of recording. The Watsonian system was criticized as being essentially dependent on only a single record for each vice-county, while modern work required much greater detail. Its merits as a framework were compared with those of a regular grid as employed in Holland, Belgium and Germany. He suggested that the 'dot' method as used chiefly in Scandinavia could be grafted on to the Watsonian system with the use of local floras, and thus distribution could be represented more accurately than by shading-in whole counties on the strength of single records. Finally he suggested that, following the example of Denmark, Holland and Belgium, a permanent committee should be set up charged with the organisation, revision and extension of the work of collecting records with collaboration from local botanists.

Dr. J. G. Dony (field secretary of the Botanical Society) then spoke on "Problems of Distribution raised in the Compilation of a County Flora". Using Bedfordshire as an example, he demonstrated with maps how the county could be divided into districts according to solid geology, drift geology, rainfall, altitude or temperature, physical features (including drainage areas) and a five-kilometre grid. In his flora he had decided to use river drainage in the body of the work and natural regions with ill-defined boundaries in the introduction. He concluded that for Bedfordshire there is no perfectly satisfactory basis for a subdivision of the county; and each county presents its own problems for which individual solutions must be found.

The proceedings of the second day of the conference were to have been opened with a paper by Capt. Cyril Diver (Nature Conservancy); but unfortunately he was prevented from being present. A letter in which he stressed the importance of the subject in connexion with plant conservation, and suggested collaboration between his own organisation and the Botanical Society of the British Isles, was read to the meeting and received with applause. In his place, Mr. C. D. Pigott (University of Cambridge) read a paper on "The Distribution of Plants in a Small Area with Special Reference to *Thymus*". Following the work of Jalas, he suggested that the British plants came under three species: *T. drucei* Ronniger em. Jalas, *T. serpyllum* L. em. Miller spp. *rigidus* (Wimm. & Grab.) Lyka em. Jalas, and *T. pulegioides* L., with somatic chromosome numbers of 54, 24 and 28 respectively. They differed in morphology, ecology, cytology and geographical distribution.

Dr. K. B. Blackburn (King's College, Newcastle) then described "Some Late Glacial Species from the Lower Tees Area and their Present Distribution". Plant remains and pollen analysis from late glacial beds at Neasham, near Darlington, were discussed, with details of the site and methods of identification. The results were compared with similar deposits in Denmark, Holland and Ireland and the present distribution of the species in Britain and abroad. The deposits included remains of *Salix herbacea* and *Betula nana*, which are now found only at higher altitudes in the latitude of Neasham. The paper was of particular interest as an example of the historical approach to the problems of distribution.

"Some Notes on Mapping the Distribution of Species" was the title of a paper by Mr. W. T. Stearn (librarian of the Royal Horticultural Society). His approach was that of a monographer of a genus and he emphasized that maps are an essential method of expressing results, since lists of localities give a false idea of distribution by breaking the range up into units. He traced the development of botanical maps from Alphonse de Candolle, who appeared to be the first to make use of this means of representing distribution. The many methods of indicating range on maps in colour and black-and-white were illustrated by a wealth of examples. The speaker stressed that the importance of correct identification suggested that maps were best prepared by monographers and specialists, and he recommended that the Society should consider issuing a base map for the British Isles. He urged that herbarium material should be the basis of the records plotted, and gave Sweden as an example of a country where adequate collections were available for the preparation of satisfactory maps.

An opportunity of comparing British methods with those based on the grid-system was afforded by the account given by Dr. A. W. Kloos, jun. (Holland) of "The Study of Plant Distribution in Holland". He explained that the method of mapping plant distribution adopted by the Instituut voor het Vegetatie Onderzoek van Nederland was based on the military map on the scale 1 : 50,000. There were fifty-eight sheets of this map and each was divided into forty-eight 'hour squares' (that is squares with sides that can be covered in about an hour's walk) of about 5,000 × 4,133 metres. Each of these was in turn divided into 'quarter squares' and further subdivision was provided for. The divisions were identified by an ingenious system of reference. The method provided for the listing by teams of workers of the species present in each 'hour square', and printed lists giving the names of all Dutch plants in a much abbreviated form were used for this purpose.

The results were transferred to distribution sheets corresponding to the sheets of the military map and printed on transparent paper with physical features shown on the reverse. These are reduced on to maps showing the whole of the Netherlands on the scale 1 : 1,500,000, of which some 2,500 have been prepared. Finally, Dr. Kloos illustrated various methods of publishing the results which had been tried before the adoption of the present system, which was clear and yet not unduly expensive. The scheme was applied to Bryophytes, Lichens, Fungi and Mollusca in addition to vascular plants.

Prof. A. R. Clapham (University of Sheffield) then reviewed the work of the conference. He said that speakers had demonstrated that an accurate and up-to-date knowledge of distribution was of great and growing importance. Such knowledge could be summarized in a convenient form in revisions of "Topographical Botany" and "Comital Flora", but to these works maps were an indispensable supplement. He suggested that in a book of 500–700 pages, each 9 in. × 11½ in., it would be possible to give four maps to the page on a scale of 1 : 10,000,000 to illustrate the distribution of all British vascular plants. He advocated the retention of county boundaries for use in collecting records, and suggested that distribution might be shown by dots where feasible, but where continuous it might be represented by shading showing four degrees of frequency. The ten-kilometre grid might also be employed. Historical information and the location of sub-fossil plants might also be shown.

Many speakers joined in the discussion which followed. An especially valuable contribution came from Prof. Cnut Fægri (University of Bergen), who said that there was a fine tradition of mapping in Scandinavia, where it was possible to map to a great extent from herbarium material. The Uppsala school used a base map with a mass of topographical detail printed in blue which was not reproduced in printing. The Swedes use old administrative boundaries and he saw no reason why we should not continue to do the same, but emphasized that these were of minor interest to botanists abroad and need not be reproduced in the printed maps. All localities should be shown on the maps, but Prof. Fægri suggested that by making the dots larger they would coalesce when distribution is continuous.

After Dr. W. B. Turrill (Royal Botanic Gardens, Kew), Prof. T. G. Tutin (University College, Leicester), Dr. E. F. Warburg (University of Oxford) and others had contributed to the discussion, the conference adopted a proposal that the Council of the Botanical Society of the British Isles should be invited to discuss the possibility of preparing and producing a series of maps of the British flora and, if it was considered practicable, to enlist the co-operation of such other bodies as may be desirable. It was suggested that Prof. Clapham should be asked to attend the meeting at which the proposal is discussed.

Throughout the conference exhibits of herbarium material and maps illustrating distribution were on view, and some of the exhibitors were able to give short talks explaining their exhibits. In addition to those staged in connexion with papers already mentioned, these included: "Distributional Studies and Generic Segregation in *Lepturus sensu* Bentham" by Mr. C. E. Hubbard (Royal Botanic Gardens, Kew); "The Topocline in *Ulmus coritana*" by Dr. R. Melville (Royal Botanic Gardens, Kew); "*Primula elatior*" by Miss D. and Mr. H. Meyer; "The Antarctic Origin of some British Carices" by Mr. E. Nelmes (Royal Botanic Gardens, Kew); "Distribution Maps of Kent Plants", by Mr. F. Rose (Bedford College, London); "The Distribution of the *Digitalis purpurea* Complex" by Mr. V. H. Heywood (Cambridge); and "The History and Distribution of some Brambles of S.E. England" by Mr. W. C. R. Watson.

After the programme of papers and discussion, a 'brains trust' again proved a useful and amusing feature. Acting as question-master, Mr. J. S. L. Gilmour introduced the members of the trust: Prof. T. G. Tutin, Drs. R. C. L. Burges, J. M. Lambert and W. B. Turrill, and Messrs. J. P. M. Brenan and R. H. Graham. The questions ranged from the justification for transplanting species to fresh localities to the pronunciation of *Erica*, and provided much useful expression of opinion in addition to a little amusement for an audience somewhat tired after two long days of serious papers.

The conference concluded with a brief summing-up by the president, who said that the Society would explore the possibility of publishing the Proceedings as they did for the last conference, and would carefully consider the proposals for preparing a set of maps and an annotated list of hybrids. Thanks were expressed to all who had helped towards the success of the conference and particularly to Dr. J. G. Dony, who was responsible for most of the organisation, and Mr. W. R. Price (assistant secretary), who undertook much of the heavy secretarial work entailed.

Two welcome features were the active part taken by botanists from abroad, and the presence and participation of young botanists. Of the former, Dr. Kloos and Prof. Fægri have already been mentioned, and Prof. R. van der Wijk (University of Groningen) also joined in the proceedings. Although time for discussion of the papers was unduly limited, a good proportion of the 160 members and guests who attended were able to contribute. It is hoped that the Botanical Society of the British Isles will be able to carry out some, at least, of the constructive suggestions which were made. J. E. Lousley

BIRMINGHAM MEETING OF THE BRITISH ASSOCIATION

SINCE its foundation in 1831, the British Association for the Advancement of Science has on five occasions held its annual meeting in Birmingham. It met there last in 1913, under the presidency of Sir Oliver Lodge; this year, when the Association visits Birmingham on the joint invitation of the City and the University, the president will be Sir Harold Hartley.

The meeting will open on the evening of August 30, when the president will deliver his address in the Town Hall. He has chosen the title "Man's Use of Energy", and it would be difficult to find a topic more appropriate to the times, or to the place of the Association's meeting. The Unesco discussion theme for the year is "Energy in the Service of Man", which differs from Sir Harold's title mainly by being capable of translation into French. This same theme will be made prominent during the meeting by discussions in several of the thirteen sections. Civil applications of nuclear energy, the harnessing of chemical energy, the use of power by primitive man, and gas turbines will come under review by the physics, chemistry,

anthropology and engineering sections respectively. An exhibition illustrating this central topic of the meeting is being organised, and a series of five public lectures on its various aspects will be given in Birmingham by distinguished speakers.

The sectional meetings will be held at Edgbaston (within the city and about three miles from its centre), in the University, King Edward's Schools and the Teachers' Training College.

At a British Association meeting, one is always torn between conflicting attractions, and the same difficulty is met in choosing subjects for mention from among the sectional programmes. A somewhat random selection on the side of the physical sciences includes "Heat Flow in the Earth's Crust" (Section A), "Chemistry of Plastics, Rubbers and Fibres" (Section B), and "Automatic Control Systems" (Section G). On the biological side, interest in Section D will centre on entomological questions, while in Section K the president's theme of modern trends in classification will be elaborated by a discussion of its cytogenetical aspects in which Section D will also join. Section K* (Forestry) will also spend an afternoon discussing the genetical aspects of forestry problems. At first thought, agriculture may seem little related to Birmingham, yet the city is, in fact, the centre of an area with diverse agricultural problems. The surrounding counties are among the best agricultural areas in Great Britain. In the Evesham district there flourishes a special combination of market gardening and agriculture, while even the Black Country has its own problem, that of rehabilitating derelict areas. All these will be reflected in Section M's programme, and Section G is taking up the specially appropriate topic of agricultural engineering. The presidential address to Section H, on "The Influence of the Potato on Social Structure", will appeal to a wide biological and agricultural, as well as anthropological, audience. Section B will discuss with Section I the chemistry of muscular contraction, and with Section K the chemistry of the cell and nucleus; while the great attraction of Section L will be an address by Dr. J. B. Conant, president of Harvard University, on "An Experiment in the Study of Science by Non-scientists".

The Evening Discourses will be given by Prof. K. von Frisch on "The Language of the Bees", by the Bishop of Birmingham (Dr. E. W. Barnes, F.R.S.) on "Science, Religion and Moral Judgment", and by Dr. A. C. B. Lovell on "The New Science of Radio Astronomy".

On Sunday, September 3, the preacher at a special service in St. Martin's Church will be the Very Rev. W. R. Matthews, Dean of St. Paul's. Representatives of the Free Churches will take part in this service.

Excursions for scientific purposes, and for pure pleasure, have long been traditional at British Association meetings. This year's programme is as full and varied as usual, ranging from factories within sight of the meeting-rooms to the source of Birmingham's famous Welsh water in the Elan Valley. Social occasions will include receptions given by the City and the University, and a garden party given by Messrs. Cadbury, Ltd.

A list is given below of the presidents of Sections and chairmen of Sub-Sections, with the titles of the addresses they will read. Further information about the meeting may be obtained from the Secretary of the British Association, Burlington House, Piccadilly, London, W.1, or from the Local Secretaries for the meeting at the Council House, Birmingham, 1.

(A) Mathematics and Physics: Prof. E. H. Neville: Mathematical Notation.

(B) Chemistry: Prof. E. L. Hirst: Modern Developments in Carbohydrate Chemistry.

(C) Geology: Dr. W. Campbell Smith: Stony Meteorites.

(D) Zoology: Dr. V. B. Wigglesworth: The Science and Practice of Entomology.

(E) Geography: Prof. S. W. Wooldridge: The Upland Plains of Britain; their Origin and Geographical Significance.

(F) Economics: Prof. G. C. Allen: Economic Progress: Retrospect and Prospect.

(G) Engineering: Prof. Andrew Robertson: A Chapter in Bridge Engineering a Century Ago.

(H) Anthropology and Archæology: Dr. R. N. Salaman: The Influence of the Potato on Social Structure.

(I) Physiology: Prof. R. J. Brocklehurst: Hormones of the Digestive Tract.

(J) Psychology: Dr. J. C. Flugel: Human Affairs and the Psychological Point of View.

(K) Botany: Dr. W. B. Turrill: Modern Trends in the Classification of Plants.

(K*) Forestry: The Right Hon. Lord Bolton: Some Post-war Forestry Problems.

(L) Education: W. F. Oakeshott: Education and Power.

(M) Agriculture: Prof. H. D. Kay: Quality in Agriculture.

THE SPANISH HIGHER COUNCIL FOR SCIENTIFIC RESEARCH

NUMEROUS representatives recently attended a most interesting and successful meeting in Madrid to celebrate the tenth anniversary of the founding of the Higher Council for Scientific Research. In recent years in all countries, government interest in the development of research facilities has been greatly extended, and various mechanisms for rendering such development possible have been put into operation. One of the most interesting of these is the Spanish experiment, the outcome of which will be well worth watching. Both in the United States and in Great Britain, continuous effort must be exercised to prevent dichotomy arising between government-sponsored research and university research. Again, the development of research on the arts side proceeds in these countries independently and without any contact with scientific progress. The concept of a 'Higher Council' on which the universities, royal academies, national defence research departments, as well as the schools of mining, of engineering, of fine arts, of sacred and political science are represented is both novel and intriguing in its possibilities.

The Council groups the various branches of science into three sections: physical, biological and spiritual subjects. Each section is composed of two trusts, and the trusts are responsible for the research institutes, museums and sections. There are now more than fifty institutes for which the Council is responsible. These are by no means all situated in Madrid, as it is the policy of the Higher Council to decentralize its activities so far as possible. Thus, for example, the Institute of Parasitology is in Granada, that of church history in Salamanca, of applied chemistry in Saragossa, and in Jaca is the Pyrenean Studies Centre.

Naturally, the main administration buildings, central and specialist libraries, the press and many working laboratories and institutes are in Madrid itself, comprising a remarkable block of modern well-constructed and expensively furnished buildings. Like the Department of Scientific and Industrial Research in Great Britain, the Higher Council provides funds for research to those who have graduated from a university, and annual prizes are given for outstanding work both in letters and in science. It is also the function of the Higher Council to advise the Minister of Education as to the award of any special prizes or life pensions for outstandingly meritorious work. One of Europe's most interesting of modern churches is the Church of the Holy Ghost, built by the Higher Council for Scientific Research in the Council Enclosure, to provide a spiritual home for all research workers, both Spanish and foreign. The Council also provides chapels in the neighbouring buildings, so that all teachers and students can make use of these during their working period.

Another interesting phase of the Higher Council's activities is to be found in the School of Ancillary Studies, in which a large staff is trained in such a way that "without entering deeply into theories, by means of a careful and practical apprenticeship they may become valuable helpers for scientific workers". British universities are in great need of the services of really skilled technicians such as glass-blowers, fine mechanics and experts in electronic circuits. It is no easy matter to obtain such valuable members of the scientific staff; and the steps which the Higher Council has taken in respect to this matter are well worth serious attention.

The foreword to the law founding the Higher Council expresses most clearly the intentions and ideas that led to its conception. "The state of divorce and discordance existing between speculative and experimental science must be terminated and the tree of science must be encouraged to develop harmoniously as a whole by avoiding the monstrous growth of some branches while others wither and die. A strong counter-weight must be found for the exaggerated and isolated specialization so prevalent in our time and the sciences must be made to regain their old sociability." A noble experiment: may it succeed.

ERIC K. RIDEAL

OBITUARIES

Dr. H. R. Mill

HUGH ROBERT MILL, distinguished geographer, meteorologist and author, died at Dormans Park, East Grinstead, on April 5, at the age of eighty-eight. He had an outstanding personality. He devoted his life mainly to the study of geography, especially of those aspects dealing with oceanography, the study of lakes, the flow of rivers, the Antarctic and rainfall. Born at Thurso, Caithness, in 1861, he became doctor of science of the University of Edinburgh, honorary doctor of laws of St. Andrews, fellow of the Royal Society of Edinburgh, honorary member of the Institution of Water Engineers and fellow or honorary member of a large number of British and foreign scientific societies.

After specializing in chemistry and physics at the University of Edinburgh, Mill became chemist and physicist in 1884 to the newly established Scottish Marine Station at Granton on the Firth of Forth. This work renewed an early interest in geography, and he was appointed lecturer in physiography in the Heriot Watt College, Edinburgh. In 1891 he published a standard text-book on geography, introducing a more systematic and scientific treatment, with the attractive title "The Realm of Nature".

From 1892 until 1900 he was librarian to the Royal Geographical Society, where he found time to make the first systematic survey of the depths of English lakes. He became recorder of Section E (Geography) of the British Association (1893–99) and president in 1901, and attained an international reputation as a geographer. On the occasion of the Society's centenary he prepared, at the request of the Council, "The Record of the Royal Geographical Society, 1830–1930". In 1915 he received the Victoria Research Medal of the Society and was vice-president during 1927–31.

In 1901 Dr. Mill, to quote his own words, seized a proffered opportunity "to devote the rest of my working life to one small portion of the great problem of my earlier dreams: the detailed investigations of the control of rainfall distribution by the forms of the land". He became director of the British Rainfall Organization at 62 Camden Square, London, and editor of "British Rainfall" and *Symons's Meteorological Magazine*, until he retired in 1919, when the Organization was incorporated in the Meteorological Office. In 1910 he presented the whole of the accumulated rainfall records and property of the British Rainfall Organisation, acquired at his own expense, to be held in trust for the nation. During this period he applied his geographical knowledge and his experience to open up new lines of research, especially in map studies of rainfall, thereby advancing the scientific study of the rainfall distributions over Great Britain. He became the authority on British rainfall and was consulted by government departments and other bodies. He was honorary secretary of the Royal Meteorological Society during 1902–6 and president in 1907–8. The Society awarded him the Symons Memorial Medal in 1918 and the newly instituted Hugh Robert Mill Medal and Prize for research in rainfall just before his death.

Although widely travelled, Mill had never entered Antarctic regions. Throughout his life, however, he maintained personal friendships with the explorers and acquired an expert knowledge of Antarctic exploration. He wrote "The Siege of the South Pole" in 1905 and "The Life of Sir Ernest Shackleton" in 1923. Illustrative of his relationships with these explorers is a telegram to Dr. Mill from Shackleton in September 1916 from Punta Arenas on his return from the far South: "My grateful thanks for friendly article about expedition and for your consistent belief in me your friend Shackleton".

Both in his lectures and writings, Mill had a happy and fascinating manner of presenting and interpreting facts. He was a source of inspiration to many in the various spheres of work which occupied his full life. In spite of eyesight already failing in 1915, he maintained throughout his life a hopeful outlook and lively interest in all aspects of "the Realm of Nature".

J. GLASSPOOLE

Mr. J. B. Scrivenor, I.S.O.

JOHN BROOKE SCRIVENOR, the first geologist to start systematic geological mapping in Malaya, died peacefully in his sleep at his home in Bedford on April 21, at the age of seventy-three.

Scrivenor was educated at the King's School, Canterbury, and Hertford College, Oxford, and after a few years as a geologist with the Geological Survey of Great Britain he was appointed Government geologist, Federated Malay States, in 1903, on contract for three years. Actually he remained there for a total of twenty-eight years until his retirement in 1931 at the age of fifty-five. He very soon established a reputation as a sound geologist and as a very tough person who was prepared to tackle any journey, no matter how difficult the conditions, and who had a most scrupulous idea of his obligations to his employer, the Malayan Government. He was said indeed to have asked Government to reduce his salary because he thought he was being overpaid. The actual facts of this unusual affair were that 'J. B.' had fallen in love with his work and with the country, and, being afraid that Government did not intend to take him on permanently, he did his utmost to ensure that it should do so by offering to serve on permanent and pensionable terms at a salary less than his initial salary on contract. His offer was accepted. He married, and returned with his bride to resume his happy life of hard work in the tropics. In 1912, he enlarged his one-man department by engaging another geologist, to be followed shortly by a chemist, and in June 1914, by another geologist, the present writer.

Apart from his geology, Scrivenor was a very keen Volunteer. For two years of the First World War he was content to serve in Malaya as a sergeant in the Volunteers, after which, although he was now a middle-aged man with a wife and four children, he returned to the United Kingdom to join the Army, and he served in France as a signals officer in the Royal Engineers. He loved his life during this period as much as any other in his very busy career, and after the War he published a small book containing an account of his experiences. The copy which he later deposited in the library of the Kinta Club at Batu Gajah was much read by his many friends. He contributed many papers to various geological journals, and during his last few years as Director of Geological Survey, Federated Malay States, he wrote two important books, "The Geology of Malayan Ore Deposits" and "The Geology of Malaya", which give a most useful and readable account of Malayan geology as known at that time. During his final years in Malaya, he also published a reconnaissance geological map of the Peninsula, the culminating result of his own jungle work and of that of his colleagues.

After retirement, Scrivenor lived in Bedford and served for some time on the town council; but he also continued his researches in geology, and indeed he had just returned from Cornwall when he died. He was a most loyal and generous friend, and he leaves behind him many who owe him much.

E. S. WILLBOURN

Mr. J. W. Williamson

THE death on March 16 of Mr. J. W. Williamson, at the age of eighty-one, will be felt as a sad loss by his many friends. He had an unusually varied career. Being forced for financial reasons to abandon medical studies at the University of Edinburgh, he was for many years a schoolmaster. At the age of forty, however, he was able to spend two years at the then Royal College of Science, and obtained an honours B.Sc. degree. He then resumed schoolmastering, but shortly before the First World War accepted a post as secretary to the Corporation of the Sons of the Clergy. In 1919 he became the first secretary to the Scientific Instruments Research Association. He remained in this post until he retired in 1936, and the present standing of the Association is due in no small measure to his efforts.

His work with the Association confirmed in Mr. Williamson a long-felt interest in the applications of science to industry, the importance of which was not so fully realized twenty-five years ago as it is to-day. He was given the opportunity of studying detailed applications in respect of two particular industries, namely, oil and railways. In 1927, at the request of the late Lord Cadman (then chairman of the Anglo-Persian Oil Company), he visited that Company's station in Persia, and, as a result, wrote "In a Persian Oil Field". A later visit to Persia, in 1938, provided him with the material for a second book concerning the company, but publication was delayed by the War. His lucid account of technological processes created such a favourable impression that he was invited by the late Lord Stamp to write a similar volume about the L.M.S. Railway. This, "A British Railway Behind the Scenes", was published in 1933. He wrote another book on railways, though in a more popular vein, called "Railways To-day", a second edition of which he was able to prepare just before his death. Another result of his interest in applied science was his connexion with the administration of the Imperial College of Science and Technology, on the governing board of which he was a representative. His assistance in the constitutional reorganisation of the College was of considerable value.

During his service with the Scientific Instrument Research Association, Mr. Williamson was called to the Bar as a member of Gray's Inn. His legal knowledge proved of great help in his work for both the Association and the Imperial College, and he published a number of papers on legal aspects of science.

In 1920 he married Helen Lee (*née* Chambers), a research botanist; she died in 1934, and he turned even more to their many friends, in whose company they had always delighted. With his varied experience Mr. Williamson combined great personal charm and a gift of imparting happiness to all who knew him.

C. A. CLEMMOW

Mr. F. Hope-Jones

THE death of Frank Hope-Jones on April 3 has taken from us an enthusiast; to everything in which he became interested during his long life of eighty-three years he applied an unbounded enthusiasm which did much to help on the project in hand.

Hope-Jones's primary interest was the application of electricity to horology, and the successful functioning of many hundreds of impulse or step-by-step propelled time installations is largely due to the application of the principles laid down and continuously championed by him, the first and foremost of which was the transmission of energy through the surfaces of the electric contact.

The free-pendulum clocks which his firm produced and installed at the Royal Observatory, Greenwich, and supplied to many other observatories scattered all over the world would probably never have come into existence had it not been for the foundation

work so emphatically laid down by Hope-Jones. His book, "Electric Clocks", published in 1931, brought up to date in 1940, and renamed "Electrical Time-keeping", has been reprinted three times and went into a second edition last year.

Just before the Second World War, Hope-Jones's enthusiasm took him, when close on seventy years of age, on a tour round the world, when he visited Australia and the United States, receiving there a John Price Wetherill Medal of the Franklin Institute in recognition of his "discovery, invention or development in Physical Science".

He was a staunch friend of William Willett and supporter of his 'daylight saving'; incidentally, this caused him to originate the six 'pips' time-signal as now broadcast daily from Greenwich. His last love was the rationalization of the calendar, and his efforts to rid us of the troubles resulting from the varying numbers of days in the month may, it is hoped, yet bring forth fruit.

Frank Hope-Jones was a member of the Institution of Electrical Engineers, a fellow of the Royal Astronomical Society, fellow and gold medallist of the British Horological Institute, and an honorary member of the Horological Society of New York. He leaves a widow and one daughter.

W. H. SHORTT

WE regret to announce the following deaths:

Dr. B. P. Babkin, F.R.S., of McGill University, distinguished for his contributions to physiology, on May 3, aged seventy-three.

Mr. H. G. Maurice, C.B., president of the Zoological Society of London during 1942–48, on May 12, aged seventy-five.

NEWS and VIEWS

Physics at University College, London: Prof. H. S. W. Massey, F.R.S.

THE transfer of Prof. H. S. W. Massey from the chair of applied mathematics at University College, London, to the Quain chair of physics is a fitting recognition of the width of his interests and achievements. After studies at the University of Melbourne, he went to the Cavendish Laboratory, Cambridge, in 1929, and carried out experimental work on the scattering of electrons in gases. He then interested himself in the theoretical side of this subject and, with N. F. Mott, published in 1933 "The Theory of Atomic Collisions", a text-book of which a second edition, much enlarged through Prof. Massey's researches, has just appeared. Apart from work on this subject he has made numerous contributions to theoretical nuclear physics, to chemical kinetics and to the theory of the upper atmosphere, and published in 1938 a monograph on "Negative Ions". During the War he held, among other positions, that of chief scientist of the Mine Design Department of the Admiralty, and was later in the United States associated with the Manhattan Project. His researches in theoretical physics are distinguished by their practical and useful nature, and by their close connexion with experimental science. In any problems concerned with scattering or collisions, the present-day physicist will look first through Prof. Massey's works if he desires reliable results in a form ready for application. In addition to his scientific work, Prof. Massey has since the War been very active as vice-president of the Atomic Scientists' Association and has spoken frequently, both in London and elsewhere, on the technical and political implications of the utilization of atomic energy.

Mathematics at the University College of North Staffordshire: Prof. I. N. Sneddon

DR. I. N. SNEDDON, who has been appointed to the chair of mathematics in the University College of North Staffordshire, is thirty years of age. He was educated first at the University of Glasgow, where he graduated B.Sc. in 1940 with honours in mathematics and natural philosophy, going later to Trinity College, Cambridge, of which he was a senior scholar in 1941. During 1942–45 he was employed as a scientific officer by the Ministry of Supply, first at the Mathematical Laboratory, Cambridge, and later at Fort Halstead, Kent. His work during this period on the properties of materials and the theory of vibrations led to advances of our knowledge of the processes involved in armour penetration and in the design of anti-tank guns. After the War, Dr. Sneddon returned to academic work as a research associate at the H. H. Wills Physical Laboratory, University of Bristol, 1945–46, where he worked with Prof. H. Frohlich on the meson theory of nuclear forces, and collaborated with Prof. N. F. Mott in the writing of "Wave Mechanics" (Oxford University Press, 1948). Since 1946 Dr. Sneddon has been a lecturer in natural philosophy in the University of Glasgow, where his work on theoretical nuclear physics has included the study of the excitation of nuclei by electrons, the energy-levels of heavy nuclei and the creation of mesons in electron-nuclei collisions. Apart from theoretical nuclear physics, Dr. Sneddon's main interest is in the boundary value problems of mathematical physics. For a discussion of the application of integral transforms to the equations of elasticity he was awarded the degree of D.Sc. by Glasgow in 1947. A work on "Fourier Transforms" is in course of publication by the McGraw-Hill Publishing Company. Dr. Sneddon's abilities as a lecturer have been widely appreciated in Glasgow. The width of his interests, both in pure and applied mathematics, makes his new appointment a particularly fortunate one.

Anthropology at the London School of Economics and Political Science: Prof. I. Schapera

PROF. ISAAC SCHAPERA, who has recently been appointed to a University chair of anthropology at the London School of Economics and Political Science, is a South African social scientist with a strong interest in applied anthropology. Prof. Schapera holds the degrees of M.A. in social anthropology from the University of Cape Town and D.Sc. in anthropology from the University of London, and was a student of both Prof. A. R. Radcliffe-Brown and of the late Prof. B. Malinowski. After holding various lecturing posts, he became professor of social anthropology at Cape Town in 1935 and has held this post until now. He was visiting professor at the University of Chicago in 1948. Prof. Schapera's field research has been carried on mainly in the Bechuana-

land Protectorate, to which he has paid many visits over a period of twenty years, but he has also twice visited East Africa, to advise on the organisation of sociological research there by the local governments and by the Colonial Social Science Research Council. His publications include a general work on the Bushmen and Hottentots and several books on the law, land tenure and social institutions of the Tswana people of the Protectorate. He has also published an important work on "Migrant Labour and Tribal Life in South Africa". Prof. Schapera is one of the most eminent authorities on the social anthropology of the South African Bantu and is interested not only in their traditional way of life but also in the problems presented by their adaptation to Western culture.

College of Aeronautics, Bletchley: A. D. Baxter

MR. A. D. BAXTER has been appointed to the chair of aircraft propulsion at the College of Aeronautics, as from September 1. Mr. Baxter is at present superintendent of the Rocket Propulsion Department at Westcott of the Royal Aircraft Establishment. He has served with the Establishment since 1935 and has had a wide experience of internal combustion engines for aircraft. He was among the first to work on gas turbine research and development, and was associated with much of the pioneer work, particularly on the problems of combustion. Towards the end of the War he became responsible for assessment and investigation of all forms of high-speed propulsion units, including the German V weapons. Mr. Baxter has, for some years, been a member of several power plants sub-committees of the Aeronautical Research Council.

Woods Hole Oceanographic Institution: Dr. Edward H. Smith

DR. EDWARD H. SMITH has been appointed director of the Woods Hole Oceanographic Institution for a period of six years, as from July 1. Columbus O'D. Iselin, director since 1940, will resign his post on that date to become senior oceanographer at the Institution. Dr. Smith, who is at present rear admiral in the U.S. Coast Guard in command of the Coast Guard's Eastern Area and Third District, is well known for his work with the International Ice Patrol. During the War, while in command of a task force, he organised a weather and beacon service across the North Atlantic, which service has now become a permanent international aid to navigation.

T. B. Osborne Medal of the American Association of Cereal Chemists

THE Thomas Burr Osborne Medal of the American Association of Cereal Chemists has been awarded to Dr. W. F. Geddes, chief of the Agricultural Biochemistry Division, University of Minnesota, for his distinguished contributions to cereal chemistry. Dr. Geddes, who is a Canadian by birth, has been prominent in both teaching and research in the field of cereal chemistry and technology for more than twenty years. He is a past president of the Association, and is the editor of *Cereal Chemistry*, the official publication of the Association. The Medal has been awarded only seven times previously since it was founded in 1926. The first award was made in 1928 to T. B. Osborne, who was for a long time connected with the Connecticut Agricultural Experiment Station.

Shape of Bubbles and Undifferentiated Cells

PROF. F. T. LEWIS, of Harvard Medical School, has recently published an interesting comparison of the shapes of soap bubbles and of undifferentiated cells (*Proc. Amer. Acad Arts and Sci.*, 77, No. 5, 149; 1949). He suggests that the shapes of such cells in bodies of many cells is dependent on the following five major variables. (1) Geometrical necessity: for example, if cells are of a uniform size they will tend towards 14-hedra, though special features may reduce the facet-number below this figure. The peripheral layer of a mass of 14-hedra will consist of 11-hedra, each of the 11-hedra making one surface of contact with the surrounding medium instead of four with surrounding polyhedra. (2) Surface tension and other forces tending to produce minimal surface area: with bubbles, surface tension can produce examples of unstackable combinations of twelve, fourteen, fifteen and sixteen facets which, if isolated and regular, have the least surface for volume. None of these shapes has yet been found among cells. (3) Cell division: this must involve forces opposed to surface tension, since division increases the total cell surface area. (4) Turgor: this again is opposed to surface tension. (5) Organisation: under this general heading Prof. Lewis includes all the processes whereby growth and division are "controlled to produce filaments, fibres, membranes or compact masses as may be proper for the organism".

Mixed-Bed De-ionization for Treatment of Water

EIGHT years ago, the Permutit Co., Ltd., of Gunnersbury Avenue, London, W.4, introduced a new technique in water treatment. This involved the use of mixed cation- and anion-exchange materials for producing high-quality demineralized water in a single step. The process has been developed, and, by the use of recently developed ion-exchange materials, it provides in a single treatment water with an electrical resistance of more than ten million ohms per centimetre cube and free from carbon dioxide and silica. The ion-exchange materials employed are 'Zeo-Karb 315', a very stable resin containing sulphonic acid groups, and the newly developed highly basic anion exchanger 'De-Acidite *F*'. When a mixed bed is used for treatment of water which has been previously distilled or demineralized by a normal technique, the effluent is of a quality previously unobtainable without multiple distillation and is suitable for use as conductivity water and in trace-element work. A further advantage is that de-ionization takes place in neutral solution, so that acid-sensitive solutions, for example, blood plasma or sugars liable to inversion and mutarotation, can be treated. Known as 'Bio-Deminrolit', the mixed ion-exchange material is finding an increasing number of uses.

Arthropod Embryology

THE Onychophora occupy a unique position in the animal kingdom and are generally regarded as lying near the base of the Arthropoda. A study of their embryonic development, therefore, is of interest not only for students of that class but also because of the light it may throw upon the embryology of the higher and more specialized classes. The material is not easy to obtain, and much of the early work suffers from inadequate technique. The first interest of a recent work by Dr. S. M. Manton ("Studies on the Onychophora, 7: the Early Embryonic Stages of

Peripatopsis, etc." ; *Phil. Trans. Roy. Soc.*, B, **233**, No. 606 ; pp. 483–580 ; London : Cambridge University Press, 1949 ; 40s.) lies in the presentation of the facts based on a plentiful supply of material mainly from four species of *Peripatopsis*, namely, *P. balfouri*, *P. sedgwicki*, *P. moseleyi* and *P. capensis* obtained from living animals in the laboratory and dealt with by up-to-date methods. The second interest of the work arises from the utilization of the data so obtained to discuss the problems related to the Onychophora and to other groups. In the former, support is given to Sedgwick's suggestion that lack of yolk in viviparous forms is secondary ; there is no evidence to support the suggestion that the lips of the 'mouth-anus' contribute to mesoderm formation, nor any indication of primary and secondary metamerism, nor of the presence of a pre-antennal segment. The observations allow of a full and interesting discussion of the segmentation of the anterior end and the relationship between this and the segmentation of the similar parts of Annelida and higher Arthropoda. No support is found for the interpretations associated with the names of Ferris and Hanke in the former, nor of Snodgrass in the latter.

Diseases and Cytology of the Amaryllids

Among the many interesting papers on floristic and geographical aspects of the Amaryllidaceæ appearing in *Herbertia* for 1948 are two contributions of specialist interest (Vol. 15. Stanford, Calif. : American Plant Life Society, 1949 ; n.p.). Philip Brierley describes several diseases of Amaryllids, excluding those of *Allium* and *Narcissus*. Red leaf spot and virus diseases appear to be the chief troubles. The former is caused by the fungus *Stagonospora curtisii*, which first produces round red spots on leaves, flower stalks and petals. These later coalesce to form larger cankers with fructifications of the fungus in the centre. Red leaf spot is bulb-borne, and may be controlled by soaking dormant bulbs in formalin solution (1 : 200) for two hours. Mosaic disease is the principal virus trouble ; it is not seed-borne, and more information on the means of natural transmission is needed. Several other diseases of minor importance are mentioned more briefly. Ernesto de Miranda Neto reports from Brazil that *Amaryllis calyptrata* and *A. stylosa* appear to be normal diploids with $2n = 22$ chromosomes ; *A. reginæ* ($2n = 33$) is regarded as a hybrid between a species with 22 chromosomes and one with 44.

Wool Industries' Research Association : Annual Report

The report of the Director of Research of the Wool Industries' Research Association for 1948–49 (Publication 188, Leeds, 1949) records some progress with the building programme and evidence of industrial experimentation and inventive activity in the combing, drawing and spinning sections of the worsted industry. The main work of the Operational Research Section has been concerned with faults in worsted yarns, and recommendations to help reduce the incidence of the faults are now being investigated. Two papers on the theory of drafting and one on sequential analysis have been prepared. Fundamental scientific studies have continued to be concerned chiefly with the mechanical properties of the wool fibre, such as the coefficient of thermal expansion of horn keratin and the bending fracture of single fibres, the electrical properties of wool, the products of enzymatic hydrolysis of wool, the setting of wool fibres, the investigation of the cystine peptides in partial hydrolysation of wool and oxidized wool. Biological research has included fleece studies on Romney and Blackface wool, and technological studies of combing oils, woollen oils and water-proofing have continued.

Archæological Records in South Australia

A recent issue of the *Records of the South Australian Museum* (**7**, No. 4) contains articles on "The Cowries of Fiji", "Two Sand-dwelling Cumacea", "A New Australian Shark", and on *Astacopsiphagus parasiticus*, and two articles of archæological interest : one, "Large Stone Implements from South Australia" by H. M. Cooper, and the other, "Some Aboriginal Camp Sites in the Woakwine Range Region of the South-East of South Australia", by T. D. Campbell and H. V. V. Noone. Both are largely catalogues of material, but are important as such. The problem in Australia is the dating of the Stone Age sites. Whether, as suggested, correlation with recent raised beaches will be possible or yield certain results remains to be seen. In the meantime, description of finds made and their comparison with other Australian material would seem to be the right procedure.

Immigration into the United States

The general subject of immigration into the United States is considered in the volume entitled "Reappraising our Immigration Policy", which is edited by Dr. Hugh Carter (*Ann. Amer. Acad. of Political and Social Science*, **262** ; March 1949). The title is misleading, however, as the articles making up the issue are factual in character, and no attempt is made to examine critically the foundations or future of American immigration policy. The contributions fall into four parts dealing respectively with the historical aspects of immigration, demographic factors, assimilation and current immigration problems. While the issue contains little that is new to the specialist, the general reader who wishes to obtain information about immigration to the United States will find it a useful compendium.

Plastics Industry in Germany

The journal *Kunststoffe*, published by Karl Hanser, of Munich, is now entering on its fortieth year. Since its beginning this journal has been able to record the successive stages in the development of the now very important plastics industry. It was founded in 1910 by Dr. Richard Escales and deals with all aspects of the industry. One of the oldest plastics was celluloid (1870) ; 'Bakelite' appeared in 1909, and the many new polymer products began about 1928. The annual production of plastics in Germany is now about 100,000 tons with a value of 300 million D.M., that of the finished products being about double. All those interested in the plastics industry will no doubt be pleased to know that this old-established publication is still flourishing.

Science Service, Washington : Election of Trustees

At the annual meeting of Science Service, Inc., held in Washington, D.C., on April 27, the following were re-elected as trustees for a three-year term : Prof. R. A. Millikan, professor emeritus, California Institute of Technology ; Prof. Ross G. Harrison, Sterling professor emeritus of biology, Yale University ; O. W. Riegel, director of the Lee School of Journalism, Washington and Lee University (*treas-*

urer); Prof. Kirtley F. Mather, professor of geology, Harvard University; and Frank R. Ford, editor, Evansville Press, Evansville, Ind. Other trustees are: Dr. Edwin G. Conklin, Princeton University; Dr. Rene J. Dubos, Rockefeller Institute for Medical Research, New York City; A. H. Kirchhofer, managing editor, *Buffalo Evening News*, Buffalo, N.Y.; Dr. Karl Lark-Horovitz, Purdue University; Dr. L. A. Maynard, Cornell University; Charles E. Scripps, Cincinnati, Ohio; Dr. Harlow Shapley, director, Harvard College Observatory (*president*); Harry L. Smithton, of La Jolla, Calif.; Neil H. Swanson, executive editor, Sun Papers, Baltimore, Md.; and Dr. Alexander Wetmore, secretary, Smithsonian Institution (*vice-president and chairman of the executive committee*). Science Service is an endowed, non-profit-making institution for the popularization of science. The board of trustees consists of fifteen representatives, three each being nominated by the American Association for the Advancement of Science, the National Academy of Sciences, the National Research Council, the E. W. Scripps Estate and by the journalistic profession. Mr. Watson Davis is still the secretary of Science Service, the address of which is 1719 N Street N.W., Washington 6, D.C.

Paris Office of the Southwest Research Institute, Texas

THE Southwest Research Institute, San Antonio, Texas, has established at 207 Rue de l'Université, Paris, an office to facilitate the handling of work for European companies and individuals similar to the three already operating in San Antonio, Houston (Texas) and New York for the North American continent. In addition to representing the Southwest Research Institute, which conducts industrial and agricultural research for companies, associations and individuals on a cost-fee basis, the Paris office also handles European matters for the Institute of Inventive Research, which serves manufacturers and inventors, and for the Foundation of Applied Research, which conducts fundamental scientific investigations in agriculture and medicine, all three being non-profit institutions founded by Mr. Tom Slick, a Texas oil producer and rancher. The director of the Paris office is M. Servan G. Cantacuzene, who is a graduate of the Universities of Bucharest and Paris, and is a former research and consulting engineer for French and Rumanian oil companies.

Royal Society of South Africa: Officers for 1950

THE following have been elected to the Council for 1950 of the Royal Society of South Africa: *President*, Prof. R. W. James; *Honorary General Secretary*, A. J. H. Goodwin; *Honorary Treasurer*, J. G. Rose; *Honorary Editor of Transactions*, Dr. F. Walker; *Honorary Librarian*, Dr. E. Newbery; *Other Members of Council*, Dr. W. F. Barker, E. Batson, Dr. J. Jackson, Dr. W. Pugh, D. L. Scholtz, Dr. J. L. B. Smith, W. J. Talbot, Dr. C. J. v.d. Horst and Dr. C. L. Wicht.

Physical Society: Officers for 1950–51

AT the annual general meeting of the Physical Society, held at the Science Museum on May 9, the reports of the Council and Treasurer and the accounts and balance sheet for 1949 were presented and adopted, and the officers and Council for 1950–51 were elected as follows: *President*, Prof. L. F. Bates; *Vice-Presidents who have filled the office of President*, Prof. C. H. Lees, Sir Frank Smith, Sir Owen Richardson, Dr. W. H. Eccles, Prof. A. O. Rankine, Mr. T. Smith, Dr. Allan Ferguson, Sir Charles Darwin, Prof. E. N. da C. Andrade, Sir David Brunt, Prof. G. I. Finch, Prof. S. Chapman; *Vice-Presidents*, Dr. W. Jevons, Mr. C. H. Collie, Prof. R. Peierls, Dr. D. Roaf; *Honorary Secretaries*, Mr. C. G. Wynne, Dr. H. H. Hopkins; *Honorary Foreign Secretary*, Prof. E. N. da C. Andrade; *Honorary Librarian*, Dr. R. W. B. Pearse; *Ordinary Members of Council*, Dr. A. C. G. Menzies, Mr. J. H. Awbery, Dr. R. C. Evans, Prof. L. C. Martin, Dr. C. E. Wynne-Williams, Dr. A. G. Quarrell, Dr. A. B. Wood, Prof. Willis Jackson, Prof. H. S. W. Massey, Mr. L. J. Davies, Prof. W. V. Mayneord, Dr. R. W. B. Stephens. Owing to the recent sudden death of Dr. H. Shaw, honorary treasurer of the Society, this office has not yet been filled.

Summer Meeting

THE Summer Meeting of the Physical Society will be held this year at the University of Liverpool on July 7 and 8, from 10.00 a.m. to 5.00 p.m. The subjects of the meeting will be nuclear physics and the theory of solids (including dielectrics). Members of the Experimental and Theoretical Physics Departments of the University will speak on the theory of solids (including dielectrics) on Friday morning, July 7; and on nuclear physics (mainly theoretical) on Friday afternoon. Saturday morning, July 8, will be mainly devoted to experimental work. On Saturday afternoon there will be a visit to the Nuclear Physics Laboratory, including the 400-MeV. synchro-cyclotron now under construction. The Conference will be open to non-members on payment of a fee of 10*s*. Inquiries for application forms should be addressed to the offices of the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7, and applications for attendance should be received at Liverpool not later than May 31.

Polydactyly in Mice

PROF. R. A. FISHER writes: "Will you please correct the statement in my letter published on March 11, p. 407, to the effect that the newly isolated gene for polydactyly is linked with leaden, *ln*. It appears, more probably, to be linked with dilute, *d*, in the second chromosome, the recombination fraction being approximately 30 per cent".

Announcements

MR. H. P. MOON, at present lecturer in charge of the Department of Zoology, has been appointed professor of zoology in the University College, Leicester. The following appointments in the College have also been made: Dr. J. R. S. Fincham to be lecturer in genetics, and Dr. C. Eaborn to be lecturer in chemistry.

THE Chemical Research Laboratory, Department of Scientific and Industrial Research, at Teddington, Middlesex, is again holding a series of 'open days' this year. There will be four sessions, on June 28 (afternoon), June 29 (afternoon), and June 30 (morning and afternoon). The afternoon of June 28 has been set aside for representatives of industrial firms who have not previously received invitations, and the director would be glad to receive applications from firms up to June 19. It is not necessary for those invited in previous years to apply again.

LOW MOLECULAR-WEIGHT POLYMERS FROM *BIS*-DIPHENYLENE ETHYLENE

By A. FOWLER WILLIAMS and R. J. S. JENNINGS
Powell Duffryn Research Laboratories, Ltd., London, S.W.11

WE have reviewed the literature concerning the formation of polymers from certain complex phenylated olefines and noted that dimers and/or trimers have been prepared and identified from asymmetrical diphenyl ethylene[1], symmetrical diphenyl ethylene[2], diphenylene ethylene[3], and acenaphthylene[4]. We found no evidence of diphenylene-diphenyl ethylene behaving similarly; but in the case of tetraphenyl ethylene, Backmann[5] noted that its formation by the reduction of benz-pinacolone with magnesium and magnesium iodide was accompanied by a yellow 'gum'.

With regard to *bis*-diphenylene ethylene, Harpe and Van Dorp[6] were the first to describe its preparation by heat treatment of fluorene with lead oxide, and they added that the red-coloured product was extracted with hot alcohol to free it from "resinous material". Since that time, there has been no published indication, so far as we are aware, of the possibility of forming polymers from *bis*-diphenylene ethylene.

Table 1

	Found				Calculated				
	% C	% H	% O (by diff.)	M. Wt.		% C	% H	% O (by diff.)	M. Wt.
A	94·41	5·05	0·54	670	Dimeric *bis*-diphenylene ethylene (*P*) or (*S*)	95·12	4·88	Nil	656
					Dimeric *bis*-diphenylene ethylene monoxide (*Q*) or (*T*)	92·86	4·76	2·38	672
B	94·11	4·54	1·35	1084	Trimeric *bis*-diphenylene ethylene monoxide (*Y*)	93·60	4·80	1·60	1000

In repeating Harpe and Van Dorp's work and that of Graebe[7], we have found that in addition to *bis*-diphenylene ethane, *bis*-diphenylene ethylene and fluorenone, there is produced a reddish-brown, high-melting, benzene-soluble, light petroleum-insoluble material, the amount of which is directly proportional to the time for which the reactants are maintained at temperatures in the region of 360° C. The yield of the high-melting material can be increased at the expense of *bis*-diphenylene ethylene by prolonging the reaction temperature in the 350–400° range. Above 450° C. the conversion proceeds mainly to fluorenone.

We isolated the complex material by extracting the reaction products with benzene, diluting the extract with alcohol and re-extracting the precipitated material with light petroleum. The residual material appeared to consist of at least two molecular species: (*a*) a reddish-brown substance (melting point 290° C. approx.) sparingly soluble in a 1 : 2 benzene–alcohol mixture, intimately mixed with (*b*) a dark brown material (melting point 335° C. approx.) virtually insoluble in the solvent mixture. These varieties were separated as acetone-soluble (*A*) and -insoluble (*B*) portions, and their analyses (see Table 1) showed fair agreement with the dimeric and trimeric forms of *bis*-diphenylene ethylene respectively.

It will be noted that the analysis of *A* agrees fairly well with that calculated for a mixture of two parts of an unsaturated dimer (see proposed structure *S*, which is isomeric with *P*) and one part of a monoxide such as *Q* or *T*, namely, C, 94·37; H, 4·84; O, 0·79 per cent. Confirmation of the existence of a structure such as *S* was afforded by a determination of the degree of unsaturation by a method based on that of Gallo, Wiese and Nelson[8]. *bis*-Diphenylene ethylene itself gave a figure of 100 per cent, whereas *A* yielded 35 per cent—again corresponding with a mixture of two parts of *S* (50 per cent unsaturation) and one of *Q*.

For further proof that the formation of *bis*-diphenylene ethylene and the high-melting complex material by the progressive oxidation of fluorene were related one to another, we heated the ethylene (melting point 187° C. corr.) for 60 hr. at 360° C. and at a pressure of 10^{-4} mm. mercury. Complete transformation into a buff-coloured benzene-soluble, acetone-insoluble material (*C*) was obtained. This turned brown at 240° C., began to melt at 275° C., but did not liquefy completely below 360° C. Analysis (see Table 2) showed good agreement with that calculated for trimeric *bis*-diphenylene ethylene.

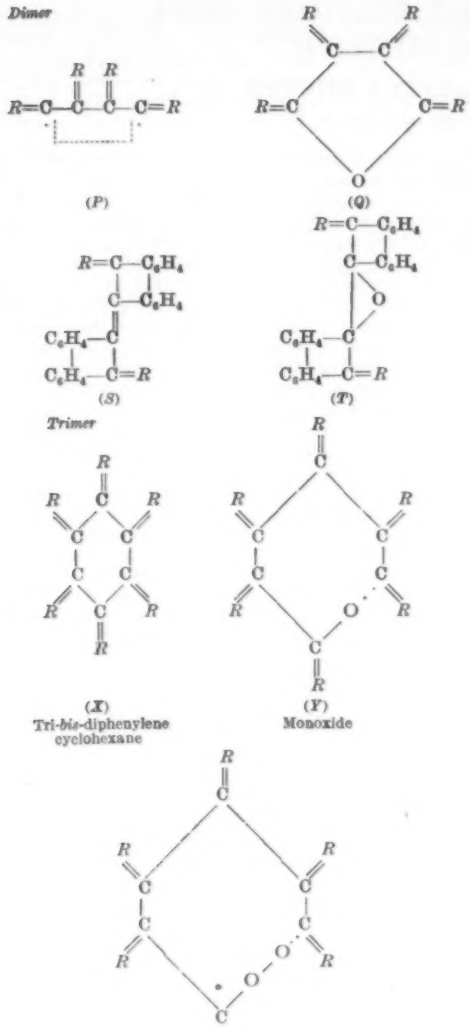
The presence of air increased the speed of 'polymerization', and when the ethylene was heated at 360° C. in a limited supply of air, the transformation was complete within 24 hr. and accompanied by a small (15 per cent) proportion of fluorenone. In this case the polymer (*D*) was reddish-brown in colour, and its analysis showed good agreement with that calculated for trimeric *bis*-diphenylene ethylene peroxide.

Table 2

	Found				Calculated				
	% C	% H	% O (by diff.)	M. Wt.		% C	% H	% O (by diff.)	M. Wt.
C	94·95	4·73	0·32	978	Trimeric *bis*-diphenylene ethylene (*X*)	95·12	4·88	0	984
D	91·79	4·51	3·70	970	Trimeric *bis*-diphenylene ethylene peroxide (*Z*)	92·12	4·72	3·16	1016

Benzoyl peroxide acted similarly to air in increasing the speed of polymerization and enabled the transformation to proceed at 300° C. Thus with 1 per cent by weight of benzoyl peroxide the ethylene yielded 66 per cent of 'polymer' after 96 hr.

The following structures are suggested tentatively for the polymers of *bis*-diphenylene ethylene (*R* is the radical $(C_6H_4)_2=$).



We are indebted to Dr. Weiler and Dr. Strauss, of Oxford, for ultimate analyses, to our colleague, Mr. G. Samuel, for the molecular weight determinations, and to the Directors of Powell Duffryn Research Laboratories, Ltd., for permission to publish this article. A fuller account will be published elsewhere.

[1] Lebedev *et al.*, *Ber.*, **56**, 2349 (1923). Schlenk and Bergmann, *Ann.*, **463**, 239 (1928). Schoepfle and Ryan, *J. Amer. Chem. Soc.*, **52**, 4021 (1930). Bergmann and Weiss, *Ann.*, **480**, 49 (1930).

[2] Clamician and Silber, *Ber.*, **36**, 4266 (1903). Liebermann, *Ber.*, **45**, 1186 (1912). Scholl and Schwarger, *Ber.*, **55B**, 324 (1922). Faller and Müller, *Monatsh.*, **79**, 615 (1948).

[3] Klages, *Ber.*, **35**, 3588 (1903). Wieland, Reindel and Ferrer, *Ber.*, **55**, 3313 (1922). Ferrer, *Anales Soc. espan. fis. quim.*, **50**, 459 (1922). Wieland and Probst, *Ann.*, **530**, 274 (1937).

[4] Dziewonski and Dolinski, *Ber.*, **48**, 1917 (1916). Crawford and Coulson, *J. Chem. Soc.*, 1990 (1948).

[5] *J. Amer. Chem. Soc.*, **56**, 449 (1934).

[6] *Ber.*, **8**, 1048 (1875).

[7] *Ber.*, **25**, 3146 (1892).

[8] *Indust. Eng. Chem.*, **40**, 1277 (1948).

MAGNETIZATION IN FERRITES

Saturation Magnetization of Ferrites with Spinel Structure

ACCORDING to Barth and Posnjak[1] there are two types of spinels XY_2O_4—one in which the X-ions occupy the 8-fold (8*f*) position and the Y-ions the 16-fold (16c) position, and another in which half the Y-ions occupy the (8*f*) position, and the X-ions and half of the Y-ions the (16c) position, with random distribution. They state that $MgFe_2O_4$ belongs to the second type. Following Verwey[2] (for a discussion of the spinel structure we also refer to this paper) we call an arrangement of the first type a 'normal' one (indicated as, for example, $Me^{II}(Fe_2)O_4$), and the second type an 'inverted' spinel (indicated, for example, $Fe(Me^{II}Fe)O_4$).

Verwey and Heilman have shown[2] that the non-ferromagnetic ferrites $ZnFe_2O_4$ and $CdFe_2O_4$ are of the normal type, and that the ferromagnetic ferrites in which Me^{II} is manganese, iron, nickel, copper or magnesium, are all of the inverted type. In mixed-crystal ferrites the divalent ions appeared to occupy the same position as in the constituent single ferrites; for example, copper – zinc ferrite (1 : 1) is

$$Zn_{0.5}Fe_{0.5}(Cu_{0.5}Fe_{1.5})O_4.$$

We have studied the saturation magnetization of various single ferrites and their mixed crystals with zinc ferrite. Some of these materials are important from the point of view of electrotechnical application[3]. They were prepared by the usual technique of sintering. No second phase was detected in any of the preparations described by either X-ray or microscopic methods. Chemical analysis showed that only very slight amounts ($\ll 0{\cdot}05$ per cent by wt.) of ferrous ions or excess oxygen (in cobalt – zinc ferrites, $\ll 0{\cdot}1$ per cent by wt.) were introduced during firing. The Fe_2O_4 was almost stoichiometric ($Fe^{++} : Fe^{+++} = 1{\cdot}04 : 2$).

The saturation magnetization per gram (σ) was measured by a ponderomotor method at field-strengths up to 5,900 oersted in all cases and at liquid-nitrogen and -oxygen temperatures. For the preparations discussed in this communication the magnetization had reached a practically constant level at these field-strengths and temperatures. No extrapolations to $H = 0$ and $T = 0°$ K. were attempted. Measurements at higher fields and lower temperatures will be reported later.

The magnetic moments M_S per 'molecule' of $Me^{II}Fe_2O_4$, expressed in Bohr magnetons (μ_B), is given by $\sigma \times$ mol. wt./$N_L \times \mu_B$ (N_L is Loschmidt's number). Values found for M_S for the single ferrites are given in Table 1, column 2.

In order to explain the fact that the published saturation magnetizations of some ferrites are low compared with the sum of the ionic moments (cf. table, column 1), Néel[4] assumed that there is a strong negative exchange interaction (that is, a strong tendency to antiparallel orientation) between the magnetic moments of ions in (8*f*) positions and those of ions in (16c) positions. These ionic moments expressed in Bohr magnetons are equal to gS. For the inverted arrangement the moments of the ferric ions (each $5\mu_B$) in (8*f*) and (16c) positions cancel each other and M_S is equal to the moment of the divalent ion $gS_{Me^{++}}$.

The agreement between the values thus calculated with $g = 2$ (column 3) and our experimental values

Table 1

	1	2	3	4	5
	Sum ionic moments ΣgS for $g = 2$	M_S experimental	M_S calculated for $g = 2$ and formula of column 5		
			gS ++	$\Sigma \pm gS$	
Manganese ferrite	15	5·0	5·0		$Fe(MnFe)O_4$
Ferrous ferrite	14	4·2	4·0		$Fe(Fe^{II}Fe)O_4$
Cobalt ferrite	13	3·3	3·0		$Fe(CoFe)O_4$
Nickel ferrite quenched from 1,250° C. or annealed	12	2·3	2·0		$Fe(NiFe)O_4$
Cupric ferrite spinel quenched from 900° C.	11	2·3	1·0		$Fe(CuFe)O_4$
Cupric ferrite tetragonally distorted spinel, annealed at 360° C.	11	1·3	1·0	~2·3	$Fe_{0.83}Cu_{1.17}$ on (8f)
Magnesium ferrite quenched from 1,250° C.	10	1·4	0		$Fe(MgFe)O_4$
Magnesium ferrite annealed at 700° C.	10	1·1	0	~1·3	$Fe_{0.86}Mg_{0.14}$ on (8f)
Zinc ferrite annealed	10	0·0		~1·4	$Fe(MgFe)O_4$
Cadmium ferrite annealed	10	0·0		~1·1	$Fe_{0.89}Mg_{0.11}$ on (8f)
'Lithium ferrite', $Li\frac{1}{2}Fe^{III}2\frac{1}{2}O_4$	12·5	2·6	2·5	0	$Zn(Fe_2)O_4$
				0	$Cd(Fe_2)O_4$
				2·6	$Fe(Li\frac{1}{2}Fe1\frac{1}{2})O_4$ $Fe_{0.99}Li_{0.01}$ on (8f)

is satisfactory. The discrepancies which remain may be due to two causes:

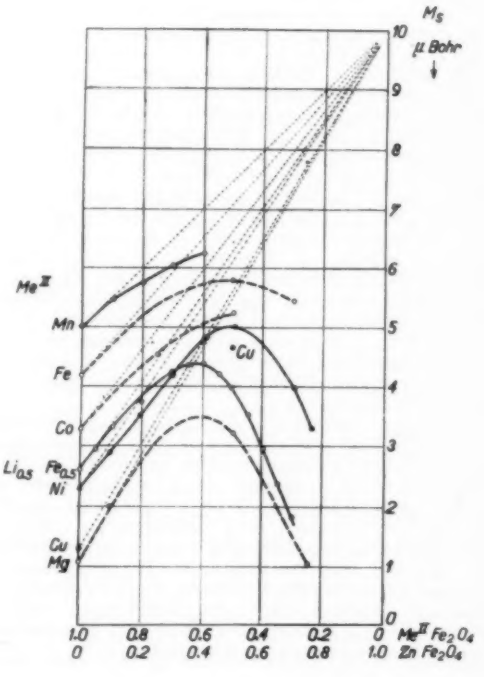
(1) A correction has to be made for g_{Me++} not being equal to 2. Beljers and Polder[5], from a gyromagnetic resonance experiment, find $g = 2{\cdot}36$ for nickel ferrite, and Bickford[6] finds for ferrous ferrite 2·09 at 143° K. (where the crystal anisotropy is zero) by a similar method. From paramagnetic measurements we know that also for Fe^{++}, Co^{++} and Cu^{++} $g > 2$, so that similar corrections have to be made[5]. For Mn^{++} and Fe^{+++}, however, $g = 2{\cdot}0$, so that for magnesium ferrite, manganese ferrite and 'lithium ferrite' ($Li_{0.5}Fe_{2.5}O_4$), no such correction need be made.

(2) The large discrepancy for copper ferrite cannot, however, be completely accounted for by this correction, and also for magnesium ferrite another explanation must be sought for its ferromagnetism.

As Néel[4] has already suggested, the cation arrangement may be incompletely inverted. The observation (Table 1) that for magnesium and copper ferrite M_S is raised by quenching is an indication of the correctness of this assumption, as higher temperatures will favour arrangements with higher entropy. Thus Brockman[7] in 1946 had observed a temperature-shift of the permeability drop just below the Curie point of copper–zinc and magnesium–zinc ferrites when quenched from different temperatures, and explained this by the migration of some magnesium or copper atoms to the (8f) position.

Even when cooling slowly, some magnesium or copper is presumably 'frozen in' in the (8f) position. Thus a formula $Fe_{1-a}Me^{II}_a(Me^{II}_{1-a}Fe_{1+a})O_4$, for which $M_S \leqslant 2a \times 5$, explains the ferromagnetism of magnesium ferrite, and the high M_S for copper ferrite. The fact that quenching from 1,200° C. does not raise M_S for nickel ferrite suggests that this ferrite has a completely inverted arrangement both in the quenched and in the annealed state. For ferrous ferrite and manganese ferrite this reasoning would not apply. In manganese ferrite a migration of some manganese ions to the (8f) position would not affect M_S, and for ferrous ferrite a partly normal arrangement probably cannot easily be frozen in, because here only the migration of an electron is needed in order to reach the condition of minimum energy[8]. We therefore must expect good agreement between experimental and theoretical values. For $Fe(Li_{0.5}Fe_{1.5})O_4$, X-ray analysis[9] proves that all the lithium ions occupy the (16c) position, even after quenching from 1,200° C. (possible error 5 per cent). In this ferrite also we must therefore expect complete agreement.

Néel extends the Weiss internal field theory to structures with two types of lattice points, like the spinel structure. With the aid of this theory he deduces from Serres's paramagnetic susceptibility data and some unpublished saturation data of Fallot a partly 'normal' arrangement for copper ferrite. He also deduces that the exchange interactions between adjacent ferric ions in (8f) and (8f) positions, and in (16c) and (16c) positions, are also negative, though much weaker than the interaction between those in adjacent (8f) and (16c) positions. On the basis of a negative (8f)–(16c) interaction only, M_S of a mixed crystal $Fe_{(1-a}Zn_a(Me^{II}_{1-a}Fe_{1+a})O_4$ is equal to $10a + (1-a)\,gS_{Me++}$. In the accompanying graph, these M_S values (represented by the dotted lines, which converge towards the value 10 for a hypothetical $Zn(Fe_2)O_4$ with parallel spins) are compared with our experimental values.



It is seen that, for all mixed crystals with small zinc ferrite content, M_S at first increases, and that the initial slope of the curves is practically equal to the slope of the dotted lines.

At higher zinc ferrite contents, M_S passes through a maximum and finally decreases towards zero. This behaviour can be explained in the following way. The strong negative (8*f*)–(16c) interaction indirectly favours parallel orientation of all moments in (16c) positions. A weaker direct (16c)–(16c) interaction exists which favours antiparallel orientation of adjacent magnetic moments in (16c) positions. In the single ferrites, the (8*f*)–(16c) interaction dominates; but as the number of magnetic ions in (8*f*) positions decreases, the (16c)–(16c) interaction is able to compete more and more with the (8*f*)–(16c) interaction, resulting in a decrease of M_S towards zero.

If from analogy with magnesium ferrite we assume that the ferromagnetic spinels Fe Mg AlO_4 and Fe $Mg_{1\cdot s}Ti_{0\cdot s}O_4$ [10] have a cation arrangement like, for example, $Fe_{1-a}Mg_a(Mg_{1\cdot s-a}Ti_{0\cdot s}Fe_a)O_4$ with small a, the low M_S values of about 0·7 μ_B [10] may be considered as a preliminary but direct indication that the (8*f*)–(8*f*) exchange interaction also is negative. The measurements are being extended to other spinels.

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Philips Research Laboratories,
Eindhoven. Dec. 23.

[1] Barth, T. F. W., and Posnjak, E., *Z. Kristall.*, **82**, 325 (1932).
[2] Verwey, E. J. W., and Heilman, E. L., *J. Chem. Phys.*, **15**, 174 (1947).
[3] Snoek, J. L., *Philips Tech. Rev.*, **8**, 353 (1946); "New Developments in Ferromagnetic Materials", 68–99 (Elsevier, 1947).
[4] Néel, L., *Ann. de Phys.*, **3**, 137 (1948).
[5] Beljers, H. G., and Polder, D., *Nature* (see following communication).
[6] Bickford, L. R., jun., *Phys. Rev.*, **76**, 137 (1949).
[7] Brockman, F. G. (private communication, 1947).
[8] Verwey, E. J. W., Haayman, P. W., and Romeyn, F. C., *J. Chem. Phys.*, **15**, 181 (1947).
[9] Braun, P. B., *Acta Crystallographica* (to be published).
[10] Verwey, E. J. W. (private communication).

g-Factors in Ferrite Materials

MAGNETISM in paramagnetic and ferromagnetic substances containing elements of the iron group is almost entirely due to the spins of the electrons in the incomplete 3*d*-shells. For the paramagnetic salts of such an element, this follows from the value of the Curie constant C in the Curie–Weiss law $\chi = C/(T-\theta)$. When χ is the mean susceptibility per magnetic ion, $C = g^2 \mu_B^2 S(S+1)/3k$. Here μ_B is a Bohr magneton, k is Boltzmann's constant and S is the total spin quantum number of the ion. In the case of completely quenched orbital magnetism, g should have a value of 2 due to spins only. The experimental values deviate slightly from 2 for several paramagnetic ions, which shows that there is a small contribution from orbital magnetism. According to theory, this is due to the combined effect of crystal electric fields and spin-orbit interaction.

A different method of studying g-values is provided by the absorption of microwaves in a paramagnetic salt placed in a large constant external field H_0. The field causes a Zeeman effect in the pattern of energy-levels of the ion. If we disregard finer details arising from the complicated structure of the pattern, we expect that, roughly speaking, maximum absorption is found when the frequency ν of the microwave is equal to $\nu = g \mu_B H_0/h$, h being Planck's constant. Generally speaking, the results of microwave experiments are in fair agreement with the conclusions drawn from susceptibility measurements.

The investigation of g-factors of ferromagnetics, either metals or non-metallic substances such as ferrite materials, is most easily carried out by the method of the absorption of microwaves, that is, by experiments on ferromagnetic resonance. It has been suggested by one of us[1] that the small deviations of g from 2 which are found experimentally are due to a mechanism similar to that present in paramagnetic salts. In this connexion it is of interest to study the g-factors of a number of nickel–zinc ferrites with varying nickel–zinc ratios. It is to be expected that the rather large g-value 2·3 found in paramagnetic nickel salts would affect the g-values of the ferromagnetic compounds containing nickel ions.

Table 2. *g*-Factors of various nickel–zinc ferrites

Composition of ferrite			Diameter of sphere	
NiO	ZnO	Fe_2O_3	3 mm.	2 mm.
0·50	0	0·50	$g = 2{\cdot}23$	$g = 2{\cdot}36$
0·35	0·15	0·50	2·03	2·15
0·25	0·25	0·50	1·87	2·07
0·14	0·36	0·50	1·88	2·11
0·11	0·39	0·50	1·88	1·95

The measurements were carried out at 3·2 cm. wave-length with the aid of a method previously described by one of us[2]. Small ferrite spheres of 2–3 mm. diameter were used. A slight discrepancy was observed (Table 2) between the g-factor for a sphere of 3 mm. and that for a sphere of 2 mm. diameter, the g-factor of the former being smaller than that of the latter. In view of the high resistivity of the material ($\simeq 10^4$ Ω cm.) skin effect can be ruled out as an explanation of this phenomenon. We believe that the effect of the dimensions of the sphere is due to the rather high permittivity ($\simeq 10$) in combination with the high permeability of the material. In these circumstances, only the smaller spheres can be assumed to be homogeneously magnetized by the microwave field. Therefore, the g-factor obtained for the 2-mm. spheres are considered to be nearer to the actual g-factor.

It is interesting to observe the striking dependence of g on the composition. In nickel ferrite, g is nearly 20 per cent larger than the 'spin-only' value. In his work on the saturation magnetization of ferrites, Gorter[3] has given arguments for believing that the magnetization in nickel ferrite is exclusively due to the nickel ions. The agreement between the g-factor of this substance and that of paramagnetic nickel salts gives additional support to Gorter's considerations. Furthermore, if it is correct that the ferric ions do not contribute to ferromagnetism, the saturation magnetization of nickel ferrite at low temperatures should be equal to $g\mu_B S = 2{\cdot}36\,\mu_B$ per molecule. This appears to be approximately the case.

According to Gorter, ferric ions together with nickel ions contribute to ferromagnetism in nickel–zinc ferrites. In agreement with this notion and with the fact that the g-factor of ferric ions as deduced from susceptibility measurements differs by only a few per cent from 2, we find g-factors which are nearer to 2 in nickel – zinc ferrites.

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Nov. 18.

[1] Polder, D., *Phys. Rev.*, **73**, 1116 (1948); *Phil. Mag.*, **40**, 99 (1949).
[2] Beljers, H. G., *Physica*, **14**, 629 (1949).
[3] Gorter, E. W. (see preceding communication).

REGULARITIES OF ISOTOPIC ABUNDANCES

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THE measured isotopic abundances of elements of even atomic number Z vary regularly and quasi-periodically. To exhibit this regularity it is necessary to plot the abundances against atomic numbers in a systematic and unambiguous manner.

It is well known that between $Z = 8$ and $Z = 40$ there is only one stable odd isotope for an element of even atomic number. The only exception to this is titanium ($Z = 22$), which has two odd isotopes. For Z greater than 40, the even elements generally, but not universally, have two odd isotopes. The simplest way of exhibiting the regularities is to plot the ratio

$$\frac{\text{Abundance of odd isotope}}{\text{Abundance of preceding even isotope}},$$

for example, the ratio (O^{17}/O^{16}). The only two elements for which there is any ambiguity are titanium ($Z = 22$), which we have mentioned above, and tin ($Z = 50$), which has three stable odd isotopes. We have not plotted the point corresponding to Sn^{115}_{50}, which is isobaric with In^{115}_{50} and which we believe to be radioactive. (This point is discussed with other detailed results in a paper now in preparation.)

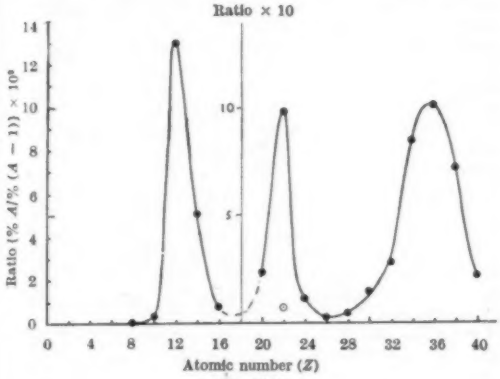


Fig. 1(*a*)

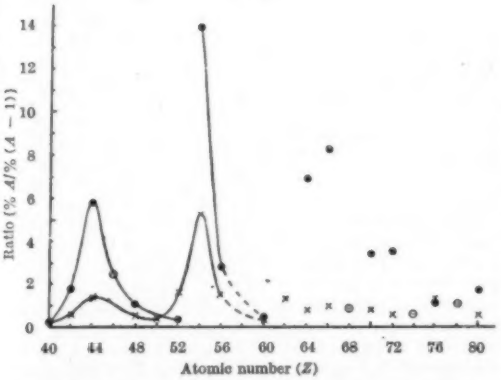


Fig. 1(*b*). ●—●—, Lower odd isotope; ×—×—, upper odd isotope; ○—○—, only one stable odd isotope

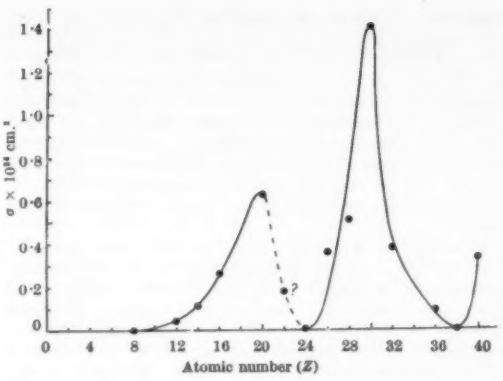


Fig. 2

Figs. 1*a* and 1*b* show the abundance ratios[1] plotted against Z. It should be noted that our procedure does not give any points at argon ($Z = 18$) and cerium ($Z = 58$), since these elements have no stable odd isotope.

Fig. 1 shows that between $Z = 8$ and $Z = 40$ there are three marked maxima, the first two being sharp and the third one broader. Above $Z = 40$, two curves are obtained corresponding to the two odd isotopes. In the gross features they are similar, but differ considerably in detail. Above $Z = 60$, the plot takes on a completely different aspect and little trace of regularity is seen. In a forthcoming paper (referred to above) we show that, in fact, periodicity is probably still present up to $Z = 80$. In this same paper we also exhibit the systematic variation of abundances in several other ways.

We wish now to discuss briefly the cause of these regularities. It seems that the explanation must be sought in a twofold hypothesis of the cosmological origin of the elements and the regular variation of some nuclear parameter with the atomic number. As regards the cosmological hypothesis, the results can be interpreted in terms of the formation of elements by neutron capture or the equilibrium theory[2]. In either case the explanation seems simplest if the nuclear parameter involved is the neutron capture cross-section. It is believed[2] on cosmological grounds that the energy of the neutrons involved must be at least 1 MeV. For such energies there are few published data on capture cross-sections. However, for nuclei which satisfy the $(1/V)$ law it might be hoped that the capture cross-section of fast neutrons would bear a simple relation to that of thermal neutrons. We have therefore examined the thermal activation cross-sections[3]. In general, the even isotope next above the odd isotope ($Z < 40$) gives, on neutron capture, a radioactive nucleus. For most of these even isotopes, therefore, the activation cross-section is known. We show in Fig. 2 a plot of the thermal capture cross-section against atomic number[3]. A related set of nuclei are the neighbouring nuclei of odd Z, for which also the cross-sections are known. Thus, if the odd isotopes of even atomic number are represented by $\binom{A}{Z}$, then the even isotopes we have plotted are $\binom{A+1}{Z}$, and the neighbouring nuclei of odd Z are $\binom{A+2}{Z+1}$. Clearly, in Fig. 2 there is a strong presumption of regular and quasi-periodic

variation. This is also true for the nuclei of type $\binom{A+2}{Z+1}$, but these are not plotted to avoid confusing the figure. A more systematic knowledge of cross-sections for many different series of nuclei will be necessary before we can be certain that they all vary regularly, and therefore provide a basis for explaining the regularities of the isotopic abundances shown in Fig. 1. But in seeking such an explanation we can, at least, be encouraged by the apparent regularity of Fig. 2.

Finally, we wish to note that the quasi-periodic form of Fig. 1 (and perhaps Fig. 2) is most easily interpreted in terms of closed nuclear shells. We therefore expect the maxima and minima of these curves to correspond with the so-called 'magic numbers'. The minima at $Z = 40$, 50 and 60 presumably correspond to $N = 50$, $Z = 50$ and $N = 82$. But the minima at about $Z = 16$ or 18 and $Z = 26$ do not correspond to any previously accepted 'magic numbers'. However, the present set of 'magic numbers' has been obtained by a detailed but rather piecemeal examination of nuclear properties[4], and it may well be that the numbers so obtained are not a complete set. The systematic examination of any one nuclear property[5], such as that shown in Fig. 1, or in Fig. 2 if indeed capture cross-sections are found to vary systematically, can be expected to give us much more information than we have at present concerning nuclear shell structure.

[1] Seaborg, Table of Isotopes, *Rev. Mod. Phys.* (Oct. 1949).

[2] Gamow and Critchfield, "Theory of Atomic Nuclei" (Oxford, 1947), gives references to the older literature, and since then there have been several papers published by Alpher and Gamow in the *Phys. Rev.* for 1947, 1948 and 1949.

[3] Values of capture cross-sections taken mainly from Seren *et al.*, *Phys. Rev.*, **72**, 888 (1947), and some, for example, nickel-62, from the Isotopic Chart of Perlman, Seaborg and Segré of Oct. 1947.

[4] Mayer, *Phys. Rev.*, **74**, 235 (1948).

[5] Gordy, *Phys. Rev.*, **76**, 139 (1949), has systematically examined the nuclear quadrupole moments.

HISTORY IN IRISH PEAT BOGS

AT a symposium on research into Quaternary history held in London in October 1946, Prof. K. Jessen's wise counsel to those interested in the history of the floras of the British Isles was to collect further evidence rather than spend time in speculation. His own very considerable contribution to this problem, the pollen-survey of Irish peat bogs, has now been published*. This survey, begun in 1934 at the instigation of the Committee for Quaternary Research in Ireland, has been supported by both Irish and Danish funds, and the analytical work was carried out in the botanical laboratories of the University of Copenhagen.

Forty-nine separate bogs, scattered through the island, have been sampled, to provide a history of both the flora and the vegetation. In this, the feature of greatest importance is the correlation of the various horizons in the Irish bogs with those of other European countries, in particular of England and Scandinavia. Thus, for the first time, a unified treatment of the vegetational history of western Europe could be attempted. In this connexion, probably the most important single item is the demonstration of an Allerød layer throughout Ireland which, as Zone II, provides a firm base line for the dating of Late-glacial deposits which have now been recognized from Ireland, in the west, to north Germany and the eastern Baltic countries.

In the first recognized period of the Late-glacial (Zone I), there is clear evidence that the whole of Ireland was treeless. A limited number of species typical of open tundra constituted the meagre flora which, however, showed alpine affinities. Ireland, therefore, represented the western extremity of a wide, almost treeless belt which extended from the Atlantic coast at least as far as Gotland and north Germany. The nearest possible refuge during this glaciation for the majority of woodland species must have been far to the south of the present Irish coast, either on the coast of Brittany or perhaps on some now submerged portion of the Continental Shelf which was exposed at this time (for even in Late-glacial time (Zone III) the sea-level was at least 120 metres lower than at present).

In the Allerød period itself (Zone II), scattered copses of birch (*Betula pubescens*) appear to have occurred, while in the north-west *Empetrum* heath predominated. With the deterioration of the climate which produced Zone III, the birch copses may have survived only in sheltered localities, and a tundra-vegetation returned until the Post-glacial period was ushered in with more sustained amelioration.

Many of the best-known members of the American and Lusitanian elements in the Irish flora are not, however, woodland species. The finding of *Eriocaulon* pollen in Zone VIIa (Atlantic), although searched for unsuccessfully in earlier zones, *Naias flexilis* fruits in Zones V and VI and *Erica Mackaii* leaves in Zones VI and VII, suggests that both these elements are composed of genuinely native species. The presence of *Erica Mackaii* in an Interglacial deposit in the same area further suggests that survival through the last glaciation in or near Ireland itself is not impossible. Such new evidence in a controversy of long standing is very welcome, and it is to be hoped that further study, especially of the southern part of the island, will extend it. On the other hand, the recent conclusion of Sealy (*J. Ecol.*, **37** (2), 365; December 1949) that *Arbutus unedo* cannot have survived glaciation in Ireland receives some support.

For Post-glacial time the most important generalization is that corresponding events appear to have occurred more or less synchronously with those of Denmark and western Europe in general. Differences of detail seem principally to have been caused by the more exposed and oceanic position of Ireland. This is expressed, for example, in the dominance of *Empetrum* heath rather than *Calluna* heath in Late-glacial and early Post-glacial time (Zones I–IV), and by a relatively late arrival of *Pinus* as a dominant. A similar picture is presented by the characteristic differences in the behaviour of oceanic species such as *Hedera* and *Ilex*, for several of which Ireland agrees more closely with Norway than with Denmark.

The maximum development of mixed oak woodland occurred in the climatic optimum of the Sub-boreal, and the subsequent general recession of woodland over the whole of Ireland, which entailed the complete elimination of the pine as a native tree, resulted from the climatic deterioration which prevented the regeneration of forests destroyed by man during the Sub-atlantic period. The first Mesolithic remains date from the Boreal and those of Early Bronze Age from the Sub-boreal.

* Studies in Late Quaternary Deposits and Flora-History of Ireland, by Knud Jessen (*Proc. Roy. Irish Acad.*, 52, Ser. B, No. 6, pp. 85–290, 1949). 25*s*.

A detailed chart correlates the events recorded for the various zones in Ireland with the stratigraphy worked out particularly by Godwin for England, Faegri for Norway, and Jessen for Denmark. This would have been more complete if the British data could have included reference to Pennington's work on the stratigraphy of the floor of Lake Windermere and Mitchell's pollen-analytical work with the South Berwickshire clays, which collectively provide some of the best evidence for Late-glacial chronology in Great Britain. This omission is, however, explained by the delay of two years during which this extremely important work was passing through the press.

H. G. BAKER

GRAVITY AS A GEOLOGICAL FACTOR

A GEOPHYSICAL Discussion on "Gravity as a Geological Factor" was held at the Royal Astronomical Society on March 3. The proceedings opened with a paper by Prof. O. T. Jones, who mentioned the various effects due to gravity, namely, landslips, creep and submarine slumping, all showing downhill movement of material. Among these effects are the structures proved in the Jurassic ironfield of Northamptonshire and the flap and cascade structures described from Iran. More doubtful in its application is the sliding under gravity in the Alps. Prof. H. Jeffreys suggested that the main effect of compression was to elevate the sedimentary rocks to such a height that the nappes became unstable and flowed downhill under gravity, thus producing the Alpine Nappes.

Prof. H. Jeffreys, in his contribution, said that after its early successes the idea of isostasy led to the supposition that at depths exceeding 50–100 km. the material behaves like a viscous fluid for low stresses lasting a long time. The added weight produced by sedimentation is able to depress the crust, but as shown by Morley Davies and by E. M. Anderson, there is a limit to this effect, and something more is needed to produce the sinking than viscous outflow.

There are two types of distribution of viscosity at depth: in the first, the 20 km. immediately under the surface has a finite strength of the order of laboratory strengths, and below this the material is viscous to great depths. In the second type of distribution the viscosity is confined to an intermediate layer. Both are contradicted by the observed distribution of gravity anomalies.

The sinking of the crust in regions of heavy sedimentation can no longer be regarded, Prof. Jeffreys said, as due to outflow produced by load. It needs spontaneous changes in a strong substratum, probably the same as those producing deep-focus earthquakes. Long fractures in a strong substratum and the infall of the outer parts could explain sinking geosynclines, ocean deeps, and rift valleys.

Dr. A. J. Bull described two types of structure which he considers have been produced by the movement of strata downhill under the force of gravity; namely, the Jura Mountains, which have moved bodily on the anhydrite beds, and a simple overfold, examples of which were shown from the London clay of Brockley and the Mesozoic cover of the Aar granite, Switzerland. He considers that gravity tends to equilibrium in the earth's crust, but this can be disturbed by radioactive heat and by changes in the specific gravity which the heat can induce.

Dr. J. G. Oldroyd referred to the rock markings mentioned by Prof. Jeffreys, and suggested that they might indicate the presence of regions in a moving rock where the yield-point is not exceeded. Slight inhomogeneity in the rock and boundary irregularities could cause the regions of actual plastic flow to occur in a complicated pattern, which might well be preserved as rock markings. Sudden fracture of a flowing rock can be accounted for by the hypothesis that a solid can rupture by flow or by fracture, with different stress criteria for the two types of failure. A gradual reduction of the hydrostatic pressure on a rock, while not interfering with the continuance of plastic flow, could make a brittle fracture increasingly probable.

Mr. N. L. Falcon showed illustrations of folding produced by gravity in the south-west of Persia. These structures were first described by Dr. J. V. Harrison and himself in the *Geological Magazine* of 1934. Particular interest is attached to the large size of the structures produced, although they are subsidiary to the main folding of the region. Their mode of origin appears to have been generally accepted by geologists throughout the world. Dr. Falcon referred to the negative gravity anomalies in the East African Rift Valley, which may be due to a considerable thickness of light sediments. Further examination is necessary in the way of bore holes and geophysical work before definite conclusions can be drawn.

Prof. S. E. Hollingworth discussed the strong disturbances produced by gravity in the Mesozoic of the Midlands, resulting in cambering and valley bulging. This has entailed a flowage in the rocks towards the valleys to a depth of at least 100 ft. below the surface. Tension in the interfluves and valley sides has produced step- and trough-faulting, while the clays at the foot of the valley slopes were crumpled, locally overturned and broken by reversed faults. He regards these structures as periglacial phenomena associated with deep perma-frost, in which the segregation of ground-water during freeze and thaw processes has played a vital part. The increased dip at the lower end of a downfaulted block is the result of sagging during tension.

Nature has in the Midlands made some moderate-scale experiments, which may help to explain the larger tensional block-faulted structures in the Western United States and in regions of rifting, when the movement of the substratum is a matter of speculative inference.

Dr. R. I. B. Cooper commented on Prof. Jeffreys's suggestion that the major variations in the level of the earth's surface might be attributed to spontaneous changes in the substratum. He said that if they were due to density variations above a given level, then they would be equivalent to the Hayford conception of isostasy; on the other hand, if the material circulated, then the principle would resemble that of Meinesz's convection currents. His own opinion is that the approximate constancy of mass per unit area over the earth's surface is a remarkable experimental fact; for example, the mass deficiency of the oceans would be expected to give a gravity deficiency of 300 mgal., whereas, in fact, variations of only about $\pm$ 20 mgal. are generally found.

Dr. Gilbert Wilson briefly summarized some cases in which sliding due to gravity has been invoked by French and Swiss geologists. Schardt was recognized as having first suggested that the nappes, after initial uplift, slid downwards under their own weight. The classic nappe theory, however, displaced this hypo-

thesis until Schneegans (*Mém. Serv. Carte géol. France*, 1938) suggested that the "Nappe du Flysch de l'Ubaye-Embrunais" in the French Alps has flowed forward like tar under the influence of gravity. He was shortly followed by Lugeon and Gagnebin, who, in a series of publications (particularly in 1941), demonstrated the importance of movement due to gravity both in the formation of the pre-Alps and among the Helvetic nappes. Despite these appeals to gravity, Lugeon and Gagnebin consider that gravitational sliding is not to be considered a substitute for the classical theories of mountain building —it is complementary to them.

Dr. Wilson went on to consider Gignoux's review (1948) of the subject (*Bull. Soc. géol. France*, 5, **18**, 739). The latter appealed to the similarities between alpine structures and those seen in glaciers where gravity takes a predominant role. Gignoux also advocated the use of true-to-scale models as a means of appreciating the relation between structure and rock-movement. Such models should have true dynamic similarity, and it was felt that, by the use of such materials as soft wet clay for 'rocks', one would be able to "understand the real orogenic phenomena . . . and perceive the nappes flowing by gravity" (Gignoux, 1948, *loc. cit.*, 758).

Dr. F. M. Trotter spoke of the use of gravity determinations in the elucidation of concealed structures in north-western England. The results of the gravimeter work by the Anglo-American Oil Company have been published in the *Quarterly Journal of the Geological Society*. A detailed survey with numerous stations at short intervals has been recently completed over an area of some forty square miles of that part of the South Lancashire Coalfield which lies beneath New Red Rocks. Relative close-packing of isogams, interpreted as indicative of lines of faulting, shows in general a broad correspondence with known lines of major fracture. There are, however, exceptions, and at present it would be unwise to claim for this method too great a precision; but the method is certainly useful in helping to determine sites at which deep borings for coal to depths of the order of 2,000–4,000 ft. would not be crossed by major faults.

SUMMARY TABLES OF BIOLOGICAL TESTS

THE Chemical-Biological Coordination Center of the National Research Council of the United States has recently announced that the publication entitled "Summary Tables of Biological Tests"* is available free of charge. The Center was established in July 1946 to succeed the war-time Insect Control Committee, and like this latter body it functions by means of subcommittees dealing with various phases of its programme. Some idea of the scope of its activities is conveyed by enumeration of these subcommittees, which deal respectively with physical chemistry, biochemistry, organic chemistry, chemotherapy, entomology, malignancy, mammalogy, medicine, microbiology, veterinary medicine, physiology-pharmacology, plant sciences and sanitary engineering; there are also a chemical codification panel, a biological codification panel and an inorganic chemistry panel.

The objects of the Center are stated to be: (*a*) to assemble and organise data for the purpose of correlating chemical structure with biological activity, (*b*) to sponsor the preliminary screening of chemicals to determine their biological effects, and (*c*) to sponsor the preparation of reviews dealing with the correlation of chemical structure with biological activity. Financial support is provided by the American Cancer Society, the Department of the Army (Chemical Corps, Corps of Engineers, Quartermaster Corps, Surgeon-General's Office), the Department of the Navy (Office of Naval Research—Division of Medical Sciences) and the United States Public Health Service (National Cancer Institute). A system is in operation for soliciting materials and arranging for their testing.

The first two numbers of Vol. 1 of "Summary Tables of Biological Tests" contain fifty-eight and sixty-two pages respectively. Tables are arranged according to the type of test employed (for example, antibacterial, arachnidicide, fungicide, insecticide, plant growth regulator, insect and rat repellency, rodenticide, mammalian toxicity, antimalarial, brucellosis and cancer tests in No. 1, and the same plus snail control and rickettsia in No. 2), the test technique is described and the chemicals tested are listed alphabetically (*Chemical Abstracts* system) and their structural formulæ are reproduced.

From the first two numbers, it is clearly impossible to judge all the activities of the Coordination Center; but it can safely be said that every type of worker is likely to find within the pages of these "Summary Tables" collected information which will be of value to him in his studies, and for the publication of which he will have cause to be grateful to the National Research Council.

* Summary Tables of Biological Tests. Sponsored by the Chemical-Biological Coordination Center. Vol. 1, No. 1, October. Pp. vi+58. Vol. 1, No. 2, December. Pp. vi+59–121. (Washington, D.C.: National Research Council, 1949.)

KOSSUTH AWARDS IN HUNGARY FOR 1950

KOSSUTH Awards in Hungary were first made in 1948 for outstanding work of a life-time, and in 1949 they were given for such achievements since the end of the Second World War. It has now been decided to make the Awards in recognition of outstanding work during the past year, and this practice will be continued in the future. Winners of the Awards for 1950 have recently been announced as follows, the value of the prizes being 10,000 forints except where otherwise stated.

Physics: the first prize (20,000 forints) jointly to Prof. P. Gombás for his work on the theory relating to the structure of noble metals and for his two books on atom physics, and to Prof. T. Neugebauer for his achievements in electron-physics research.

Agricultural Science: Prof. R. Manninger (20,000 forints) for the discovery of a vaccine against swine erysipelas; K. Sedlmayer, plant improver, for the improvement of sugar beet, autumn barley, flax and vetches; and L. Kreybig, research director, for work on the drafting of a geological map of Hungary and his new method of applying artificial fertilizers.

Mathematics: Prof. L. Rédei (20,000 forints) for research in the theory of numbers and the theory of groups; Prof. L. Kalmár, for investigations in mathematical logic; and Prof. B. Szökefalvi-Nagy, for work on Hilbert space and Fourier series.

Chemistry : Prof. T. Erdei-Gruz, for investigations of catalytic and corrosive processes ; Prof. G. Fodor, for work on the stereometric structure of organic compounds and for the synthesis of certain medicines ; and Prof. Z. Szabó, for work on the theory of the mechanism of reactions important to industry.

Medicine : Prof. G. Heténvi, for investigation of correlations between the brain and stomach ulcer ; Prof. J. Szentágothai, for the investigation of correlations between the labyrinth and the action of the eye-muscles ; I. Kemény, chief medical officer, for work in connexion with lower dentures prepared on the basis of anatomical and physiological investigations.

Technology : M. Freund, for the production of lubricating oils, washing powders and wax substitutes from Hungarian mineral oil ; Prof. J. Varga, for the conversion of Hungarian mineral oils into aromatic compounds ; E. Winter, for work on the technology of radio waves ; and Prof. G. Tarján and K. Martini, engineer, for work on the conversion of coal from the Komlo mines into coke.

Technical Reconstruction : K. P. Pfeiffer, engineer (20,000 forints), for innovations in the methods of gasification of lignite and in gas generators ; A. Gerecs and J. Kolonics, chemists (20,000 forints jointly), the former for making possible the production of vitamin P, vitamin B_1, pyrocatechin, papaverin and *p*-amino-salicylic acid (for use in treating tuberculosis) from Hungarian raw materials, and the latter for important innovations in the production of 'ultraseptil' (sulphanyl drugs) and papaverin preparations ; L. M. Zsolnai, chemist, for the substitution of Hungarian raw materials for imported material for the manufacture of porcelain insulators ; M. Fülöp, technician, for several innovations, one of which—spongy hard chromium plating—involves an annual saving of 1,700,000 forints ; L. Frank, foundry engineer, for his innovations in connexion with the casting of grey iron, which increased twofold the tensile strength of grey iron.

U.S. NATIONAL ACADEMY OF SCIENCES

ANNUAL MEETING

THE National Academy of Sciences, at its annual meeting held in Washington, D.C., during April 24–26, elected the following officers, new members and foreign associates.

President for a four-year term ending in 1954 : Detlev W. Bronk, president of Johns Hopkins University and chairman of the United States National Research Council.

Foreign Secretary for a four-year term ending in 1954 : Roger Adams, head of the Department of Chemistry, University of Illinois.

Members of the Council of the Academy, for a three-year term ending in 1953 : Oliver E. Buckley, president of the Bell Telephone Laboratories ; and Walter S. Hunter, chairman of the Department of Psychology, Brown University.

New Members : Francis Birch, professor of geophysics, Harvard University ; S. Bochner, professor of mathematics, Princeton University ; James Bonner, professor of biology, California Institute of Technology ; Ernst Cloos, professor of structural geology, Johns Hopkins University ; Lyman C. Craig, member of Rockefeller Institute for Medical Research, New York ; Lester R. Dragstedt, chairman of the Department of Surgery, University of Chicago ; David R. Goddard, chairman of the Department of Botany, University of Pennsylvania ; Herbert S. Harned, professor of chemistry, Yale University ; G. Evelyn Hutchinson, director of graduate studies in zoology, Yale University ; M. R. Irwin, professor of genetics, University of Wisconsin ; E. C. Kendall, head of the Section on Biochemistry, Mayo Clinic, Rochester ; Gerard P. Kuiper, professor of astronomy, Yerkes Observatory, University of Chicago ; W. F. Libby, professor, Institute for Nuclear Research, University of Chicago ; Fritz A. Lipmann, head of the Biochemical Research Laboratory, Massachusetts General Hospital, Boston ; R. Lorente de No, member of Rockefeller Institute for Medical Research, New York ; Frank C. Mann, professor of experimental medicine, Mayo Foundation, University of Minnesota ; Kenneth F. Maxcy, professor of epidemiology, School of Hygiene and Public Health, Johns Hopkins University ; C. E. Kenneth Mees, director and vice-president in charge of research, Eastman Kodak Co., Rochester ; E. V. Murphree, president and director, Standard Oil Development Co., 15 West 51st Street, New York ; Alfred O. Nier, professor of physics, University of Minnesota ; Arthur E. Raymond, vice-president and director, Douglas Aircraft Co., Inc., Santa Monica ; Bruno B. Rossi, professor of physics, Massachusetts Institute of Technology ; B. F. Skinner, professor of psychology, Harvard University ; J. A. Stratton, provost of the Massachusetts Institute of Technology ; Victor C. Twitty, chairman of the Department of Zoology, Stanford University ; George Wald, professor of biology, Harvard University ; Howel Williams, chairman of the Department of Geological Sciences, University of California ; Ralph E. Wilson, astronomer, Mount Wilson Observatory, Pasadena ; Oskar Wintersteiner, head of the Division of Organic Chemistry, Squibb Institute for Medical Research, New Brunswick ; and M. L. Wolfrom, head of the Division of Organic Chemistry, Ohio State University.

Foreign Associates : C. H. Best, director of the Banting and Best Department of Medical Research, University of Toronto ; and A. J. Kluyver, professor of microbiology, Technical University of Delft.

Medal Awards

The Academy has made the following medal awards.

Henry Draper Gold Medal for 1949, to Prof. Otto Struve, Andrew MacLeish distinguished service professor and chairman of the Department of Astronomy, University of Chicago, in recognition of his contributions to astronomical physics, the most notable of which are his observations of stars with peculiar spectra and his development of theories of the structure of stellar atmospheres.

Daniel Giraud Elliot Gold Medal for 1946, to Dr. Robert Broom, keeper of vertebrate palæontology and anthropology, Transvaal Museum, in recognition of his many scientific articles and books, particularly his part in the book entitled "The South African Fossil Ape-Men, the Australopithecinæ", which was published in 1946.

Mary Clark Thompson Gold Medal for 1949, to Dr. Lauge Koch, of Copenhagen, for most important services to geology and palæontology, by his organisation and pursuit of exploration and geological studies in East Greenland, often under the most arduous conditions.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Air-speed/Wing-tip Speed Ratios of Insect Flight

I HAVE made measurements of the wing movements of the tsetse-fly *Glossina palpalis* R-D. and other *Glossina* species in free flight, using a stroboscope and a large series of 'Arditron' flash photographs (duration about 1–2 microseconds). The wing-beat frequency for *G. palpalis* is 120 cycles per second; but investigation shows that the relative speeds of the 'up' and 'down' strokes are far higher. The times taken for the 'up' (return) stroke and for the 'down' stroke are approximately equal and have been estimated at 0·001 sec., whereas the time for the whole cycle is 0·008 sec. Two milliseconds are 'wasted' at the completion of the 'down' stroke and four milliseconds at the completion of the 'up' stroke. The wing-tips describe a distorted and flattened figure of eight, the axis of this 'figure' being set between angles varying between 30° and 80° to the horizontal axis of the insect. The angle is varied by the insect to regulate speed, and for turning, since it is apparently unable to change its wing-beat frequency. The maximum movement of the down stroke, measured along the arc, is 15·4 mm. and the up stroke is 20·3 mm.

Kennedy, Ainsworth and Toms[1] give avowedly very rough comparative figures for the wing-beat frequencies, wing-tip speeds and air speeds for the mosquito *Aedes ægypti* L. and the locust *Locusta migratoria migratorioides* R. and F. The data for the mosquito were taken from David[2]. Here my main interest concerns the ratio of speeds between wing-tip and the whole insect, which is shown in a copy of Kennedy's table below in which my own data on the tsetse-fly *Glossina palpalis* have been included. If the wing-tip speeds given were actual speeds, these figures would indicate that the locust is extraordinarily efficient in flight, which is rather contrary to the impressions gained when watching a flying swarm of locust in Nature. Using the same basis of comparison as Kennedy *et al.*, the data show that the forward movement of *Glossina* is about four times faster than its wing-tips, which, of course, is quite ridiculous.

Table 1

	Mosquito *Aedes ægypti*	Locust *Locusta m. migratorioides*	Tsetse *G. palpalis*
Weight of insect (mgm.)	2	2,000	25
Wing-beat frequency (cycles per sec.)	440	20	120
Mean wing-tip speed (cm./sec.)	220	360	214
Air speed of whole insect (cm./sec.)	17	275	770
Ratio of speeds, wing-tip to whole insect	13	1·3	0·28

In fact, Kennedy's figures for wing-tip speed were not given as actual speeds, being less than the actual for two reasons. First, Kennedy and David appear to have measured the wing-tip displacement as if it were a straight line and, moreover, a vertical straight line in the case of the locust. The actual displacements must have been greater owing to the curved path traced out by the wing-tip. No correction can be made for this as the shape of that path is not known for the mosquito and locust. Secondly, the wing-tip speeds quoted for the mosquito and locust were mean speeds, including the time 'wasted' at the completion of each 'up' stroke and 'down' stroke. A correction can be made for this in the case of the locust. Kennedy *et al.* (ref. 1, p. 25) show in a graph the variations of the wing angle plotted against time for a 'flying' locust; the time taken to complete one wing-beat cycle being 0·042 sec., or a wing-beat rate of 24 c./s. Omitting the time when the angular velocity of the wing in the vertical plane is small (that is, the time 'wasted' at the end of each stroke), the time taken for the up stroke is only 0·010 sec. and for the down stroke 0·017 sec. This gives a greater velocity to the wing-tip than the mean time taken for the whole cycle. W. H. Walton[3] gives additional data on the wing-beat frequencies of *Aedes*, and J. S. Kennedy, in a private communication, points out that he recorded the speed of 150 cm./sec. for *Aedes* in 1939[4] and that the speed of about 600 cm./sec. was recorded for *Schistocerca gregaria* Forskål by Gunn, Perry *et al.*[5], and, although this is a different species of locust, *migratorioides* certainly flies faster than the figures he gives. From these data, and my own for *G. palpalis*, we can calculate the values given in Table 2.

Table 2

	Mosquito	Locust	Tsetse
Air weight of insect (mgm.)	2	2,000	25
Wing-beat frequency (cycles per sec.)	650	24	120
Mean wing-tip speed, up and down strokes (cm. per sec.)	300	1,500	1,780
Max. forward air speed (cm./sec.)	150	600*	770
Ratio of speeds, wing-tip to whole insect	2·0	2·5	2·3

* Maximum recorded for a locust, but not for *L. m. migratorioides*.

It must be remembered that the figures for the mosquito and locust have been obtained from different sources, and are not strictly comparable; but the data now suggest that there is probably a constant ratio between wing-tip speeds and forward air speeds, which may be true for a large number of insects.

The weight of *Glossina* and other insects varies according to whether they have recently fed or not, and often with the two sexes. The weight given for *Glossina* is the mean for hungry flies from the same locality as those used in the speed measurements. Dr. Kennedy informs me that the figures for *Aedes* refer to sugar-replete females and those for *Locusta* are about half-way between the mean weight of males (1·5 gm.) and that of females not yet gravid (2·5 gm.).

The maximum observed forward movement of *G. palpalis* is 6·1 cm. per wing beat, giving a maximum speed of approximately 16 m.p.h.

The experiments to date also suggest that the antennæ act as air-speed and air-current indicators (besides other functions) and that the first part of the up stroke, where the wings are brought back horizontally in a paddle-like action, gives the maximum forward thrust. They also confirm previous findings[6] that the halteres vibrate in an opposite direction to the wings.

I am grateful to Dr. J. S. Kennedy for his helpful comments and to Colonel H. W. Mulligan, director

of the West African Institute for Trypanosomiasis Research, for permission to publish this note.

F. L. VANDERPLANK

West African Institute
for Trypanosomiasis Research,
Vom. P.O. Bukuru,
Northern Nigeria. Jan. 6.

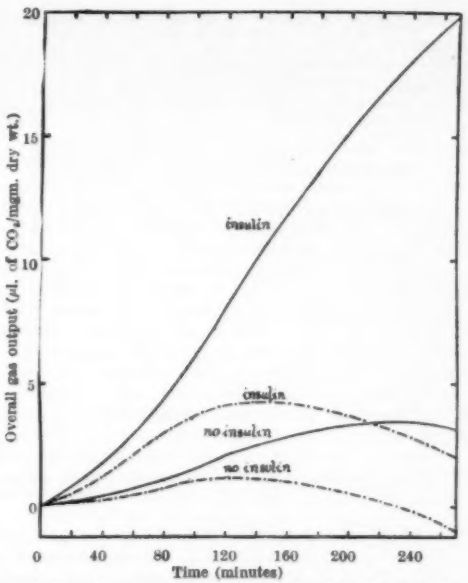
[1] Kennedy, J. S., Ainsworth, M., and Toms, B. A., Anti-Locust Bull. 2 (British Museum, 1948).
[2] David, W. A. L., *Bull. Ent. Res.*, **38**, 373 (1946).
[3] Walton, W. H., Porton Tech. Paper No. 12 (1947).
[4] Kennedy, J. S., *Proc. Zool. Soc. Lond.*, A, **109**, 221 (1939).
[5] Gunn, Perry, *et al.*, Anti-Locust Bull. No. 3, 45 (1948).
[6] Vanderplank, F. L., Thesis, University of Bristol (1947).

Stimulation by Insulin of *in vitro* Fat Synthesis by Lactating Mammary Gland Slices

A ROLE for insulin in the regulation of fatty acid synthesis from acetate seemed to be suggested by the work of Bloch and Kramer[1] who, using acetate labelled with carbon-14, reported that the utilization of acetate for fatty acid synthesis by rat liver slices *in vitro* was enhanced by insulin when pyruvate was also present in the medium but not if the medium contained acetate alone or plus glucose. However, Bloch[2] afterwards reported failure regularly to reproduce these results, and the general significance of his original observations therefore seemed doubtful.

We have previously pointed out[3,4] the outstanding properties of lactating mammary gland as a tissue for the *in vitro* study of fat synthesis. As judged by the high respiratory quotient ($R.Q. > 1$), mammary gland slices will rapidly synthesize fat *in vitro* from carbohydrate (non-ruminants) or acetate (ruminants) as sole substrate respectively[3-5]. Moreover, in presence of glucose, rat or rabbit mammary tissue, almost inert to acetate alone, will utilize considerable quantities of acetate under conditions (Q_{O_2} usually increased; maintained $R.Q. > 1$) which suggest that it is incorporated into fat. Correspondingly, ruminant mammary gland slices also seem to utilize acetate for fat synthesis at an enhanced rate in presence of glucose[4,6]. It is therefore interesting to record that, using this particularly favourable system, we have been able to demonstrate what appears to be a marked stimulation by insulin of fat synthesis *in vitro*.

The methods for studying the respiration of mammary gland slices were as previously described[3,4], a few of the earlier experiments being done on tissue from lactating rabbits but most on tissue taken from rats at days 12–18 of lactation. Results illustrative of numerous 3-hr. respiratory measurements carried out, as previously[4,6], in presence of 0·1 per cent glucose and 0·02 *M* acetate are given in Table 1. The increases in respiratory quotient (always greater than 1) and acetate utilization ($\simeq Q_{acid}$) are evidence of a stimulating effect of insulin on milk fat synthesis. Our failure in earlier experiments to obtain these



Respiration of mammary gland slices from hooded rat at eighteenth day of lactation.
Medium: saline–bicarbonate (Krebs); pH 7·4. Gas phase: 95 per cent oxygen, 5 per cent carbon dioxide. Temperature: 37°. Substrates: 0·3 per cent glucose + 0·02 *M* sodium acetate (unbroken curves), 0·1 per cent glucose + 0·02 *M* sodium acetate (dotted curves). Insulin: crystalline insulin ('Novo'), free from glycogenolytic factor, added to 1 I.U./ml.

effects with crystalline insulin was probably due, not as then suggested[6] to the need for *o*-cresol (present as a preservative in the always effective 'regular' insulin) as a component of the system, but to the relative insolubility of the insulin under the conditions then used.

More favourable conditions for demonstrating this insulin effect were indicated by measurements of the time-course of the overall pressure change in ordinary Warburg vessels (see graph). With 0·1 per cent glucose and 0·02 *M* acetate there is a definite initial stimulation (raised *R.Q.*) by insulin; but the respiratory quotient ultimately begins to fall so that the values determined over 3 hr. under-estimate the effect. With 0·3 per cent glucose and 0·02 *M* acetate, however, the effect of insulin on the overall gas exchange is much more marked from the outset and the curve of excess carbon dioxide production is practically linear over 4 hr. With 0·3 per cent glucose in presence of 0·02 *M* acetate, therefore, 3-hr. *R.Q.* determinations should give a true measure of the insulin effect.

The results of ten such determinations on rats, given in Table 2, indicate that in presence of crystalline insulin ('Novo'), respiratory quotient values in the neighbourhood of 2 can regularly be obtained with

Table 1. EFFECT OF INSULIN ON UTILIZATION OF ACETATE AND GLUCOSE BY LACTATING MAMMARY GLAND SLICES
Substrate: 0·1 per cent glucose + 0·02 *M* sodium acetate. Medium: saline-bicarbonate (Krebs), pH 7·4. Gas phase: 95 per cent oxygen, 5 per cent carbon dioxide. Temperature: 37°. Duration of experiment: 3 hr. Final concentration of insulin: 1 I.U./ml.

Animal No.	$-Q_{O_2}$			Q_{acid}			*R.Q.*		
	Insulin	No insulin	Δ	Insulin	No insulin	Δ	Insulin	No insulin	Δ
Rabbit No. C 5	9·1	8·3	0·8	−7·3	−4·4	−2·9	1·72	1·23	0·49
Rabbit No. 101	11·7	10·6	1·1	−9·1	−6·3	−2·8	1·66	1·20	0·46
Rabbit No. C 4	12·3	10·1	2·2	−9·2	−6·0	−3·2	1·63	1·28	0·35
Rat No. 24	9·2	10·8	−1·6	−2·6	−1·7	−0·9	1·56	1·24	0·32
Rat No. 27	11·8	10·3	1·5	−5·1	−3·5	−1·6	1·60	1·40	0·20
Rat No. 63	8·8	8·6	0·2	−1·9	−2·3	+0·4	1·47	1·34	0·13

Table 2. Effect of Insulin on Utilization of Acetate and Glucose by Lactating Mammary Gland Slices

Substrates: 0·3 per cent glucose with or without 0·02 *M* acetate. Medium: saline-bicarbonate (Krebs), pH 7·4. Gas phase: 95 per cent oxygen, 5 per cent carbon dioxide. Temperature: 37°. Duration of experiment: 3 hr. Crystalline insulin ('Novo'), free from glycogenolytic factor, dissolved in the minimal amount of sodium hydroxide and added to give a final conc. of 1 I.U./ml.

No. of rats	Addition	Glucose			Glucose + acetate		
		$-Qo_2$	Q_{acid}	*R.Q.*	$-Qo_2$	Q_{acid}	*R.Q.*
10	Insulin	10·4	1·7	1·80	13·4	−4·6	2·03
	No insulin	9·2	1·7	1·57	10·5	−2·1	1·53
Probability that a difference between the means, insulin *v.* no insulin, at least as great as that observed would have occurred by chance		n.s.	n.s.	<0·001	<0·02	<0·001	<0·001

The effect of insulin on the mean *R.Q.* was significantly greater in presence of acetate than in its absence ($P < 0{\cdot}001$). The probabilities were obtained by analysis of variance.

tissue taken at the height of lactation (12–18 days), the mean for the corresponding determinations without insulin being 1·53. At the same time, insulin markedly increases the respiration (by contrast with previous *in vitro* results with other tissues) as well as the acetate utilization. These striking effects of insulin were more marked in presence of both substrates, though in most experiments they were also obtained with 0·3 per cent glucose alone. No significant effects were seen with acetate alone.

Since tracer experiments *in vivo* have shown that the lactating mammary gland can rapidly synthesize milk fat from small units[7,8], there is little reason to doubt that under our conditions a high respiratory quotient indicates net fat synthesis by mammary gland slices; hence these results may be interpreted as evidence that insulin here has a role as a regulator of fatty acid synthesis from carbohydrate and acetate in an extra-hepatic site. It is noteworthy that this insulin effect is of such a magnitude as to be easily demonstrable by classical manometric methods. Further experiments to elucidate the general significance of these observations are in progress; it may, however, be noted now that they are in accord with previous results from experiments *in vivo* (see, for example, refs. 9, 10), indicating that insulin is concerned in lipogenesis from carbohydrate.

We are indebted to Mr. C. P. Cox for statistical analysis of the results, and to Dr. K. Hallas-Møller of Novo Terapeutisk Laboratorium, Copenhagen, for supplies of crystalline insulin devoid of glycogenolytic factor.

Judith H. Balmain
T. H. French
S. J. Folley
National Institute for Research in Dairying, University of Reading. April 10.

[1] Bloch, K., and Kramer, W., *J. Biol. Chem.*, **173**, 811 (1948).
[2] Bloch, K., Cold Spring Harbor Symp. Quant. Biol., **13**, 29 (1948).
[3] Folley, S. J., and French, T. H., *Biochem. J.*, **45**, 117 (1949).
[4] Folley, S. J., and French, T. H., *Biochem. J.*, **46**, 465 (1950).
[5] Folley, S. J., and French, T. H., *Biochem. J.*, **43**, lv (1949).
[6] Folley, S. J., and French, T. H., *Biochem. J.*, **44**, xlv (1949).
[7] Popják, G., Folley, S. J., and French, T. H., *Arch. Biochem.*, **23**, 509 (1949).
[8] Popják, G., French, T. H., and Folley, S. J., *Biochem. J., Proc. Biochem. Soc.* (March 24, 1950).
[9] Drury, D. R., *Amer. J. Physiol.*, **131**, 536 (1940).
[10] Stetten, D., jun., and Boxer, G. E., *J. Biol. Chem.*, **156**, 271 (1944).

Biological Action of X-Rays, Nitrogen Mustards, Diepoxides and Peroxides

Organic peroxides have recently been shown to be mutagenic[1] and to induce chromosome abnormalities in *Vicia faba*[2]. The broad similarity of the effects produced by the nitrogen mustards and the diepoxides[3], which almost certainly react by a carbonium ion mechanism, and those produced by X-rays and peroxides, which react by a free radical mechanism, prompts one to look for similarities in their mode of action. At least two points of similarity may be observed: (*a*) Free radicals, like carbonium ions, are electrophilic reactants[4]; (*b*) the reaction of a carbonium ion derived from a mustard molecule with a nucleophilic centre in a biological system gives a product which is still electrophilic owing to the reactivity of the second halogen atom. Likewise, the reaction of a free radical with such a centre can also lead to the production of an electrophilic centre (see below). Schematically:

$$(A) + (B) \rightarrow (C) \rightarrow (D).$$

A is the reacting centre in the system, *B* the reactant, *C* the intermediate product, and *D* the electrophilic centre derived from *C*.

Note that, in each case, the nucleophilic centre of the original system is converted into a highly reactive electrophilic centre. The above change is shown in detail below for a typical nucleophilic centre—the ionized carboxyl group of a protein.

Nitrogen Mustards

$$\underset{(A)}{-CH_2CO_2^-} + \underset{(B)}{CH_2CH_2\overset{+}{N}CH_2CH_2X} \rightarrow$$

$$-CH_2CO_2CH_2CH_2\underset{(C)}{NCH_2CH_2X} \rightarrow$$

$$-CH_2CO_2CH_2CH_2\underset{(D)}{NCH_2CH_2^+}.$$

Diepoxides

$$-CH_2CO_2^- + \overset{+}{C}H_2CHCHCH_2 \xrightarrow{H^+}$$

$$-CH_2CO_2CH_2CHCHCH_2 \rightarrow$$

$$-CH_2CO_2CH_2CHCHCH_2^+$$

$$(D)$$

Free Radicals

$$-CH_2CO_2^- + \cdot OH \rightarrow -CH_2CO_2\cdot + OH^- \rightarrow$$

$$-CH_2\cdot + CO_2$$

$$(D)$$

The new electrophilic centre could react further in many ways: for example, it might react (*a*) with a nucleophilic group on the same 'surface', or (*b*) with a group on a different surface. Possibility (*a*) has been implied in a recent note[5] on the action of X-rays and methyldi-(2-chloroethyl)amine on nucleic acids. It is considered possible that the reaction of the new system in this way would result in breaking down the nucleic acid structure and so account for the observed viscosity decrease. The second possibility amounts to a cross-linkage reaction; this has already been suggested[6]. The further reaction of the system with a nucleophilic grouping could proceed thus:

Nitrogen Mustards

$$-CH_2CO_2CH_2CH_2\overset{|}{N}CH_2CH_2^+ + R.CO_2^- \rightarrow -CH_2CO_2CH_2CH_2\overset{|}{N}CH_2CH_2O_2C.R.$$

Diepoxides

$$-CH_2CO_2CH_2\underset{OH}{\underset{|}{CH}}\underset{O^-}{\underset{|}{CH}}CH_2^+ + R.CO_2^- \xrightarrow{H^+} -CH_2CO_2CH_2\underset{OH}{\underset{|}{CH}}.\underset{OH}{\underset{|}{CH}}CH_2O_2C.R$$

Free Radicals

$$-CH_2\cdot + R.CO_2^- \xrightarrow{H_2O} -CH_2CO_2R + H\cdot + OH^-.$$

Preliminary results obtained by Mr. S. H. Revell of this Institute suggest that whereas chemical reagents of both types, the mustards and the diepoxides on one hand and the peroxides on the other, appear to produce breakage of the long chromosome of *Vicoa faba* at specific regions—probably those normally regarded as heterochromatic—the effect of ionizing radiations is to produce a more random breakage. This is understandable, since the radiation can produce an active radical anywhere within a cell and at any locus in a chromosome, but chemical reagents must penetrate the cell by a diffusion process and all sites need not be equally accessible.

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[1] Dickey, F. H., Cleland, G. H., and Lots, C., *Proc. U.S. Nat. Acad. Sci.*, **35**, 581 (1949).
[2] Revell, S. H. (unpublished work).
[3] Loveless, A., and Revell, S. H., *Nature*, **164**, 938 (1949).
[4] Waters, W. A., "The Chemistry of Free Radicals", 183 (Oxford University Press, 1946).
[5] Butler, J. A. V., Gilbert, L., and Smith, K. A., [*Nature*, **165**, 714 (1950)].
[6] Goldacre, R. J., Loveless, A., and Ross, W. C. J., *Nature*, **163**, 667 (1949).

Determination of the Ionic Exchange during Nervous Activity by Activation Analysis

EXPERIMENTS on the sodium and potassium content of cells, and on the part played by these ions in nervous conduction, have often been hampered by the inconvenience and insensitivity of conventional methods for the estimation of the alkali metals. The advent of radioactive isotopes has given a new impetus to such studies; but the necessity for knowing the intracellular ionic concentrations remains. In working with isolated nerve axons, for example, although the inward ionic fluxes can be measured directly with potassium-42 and sodium-24, the outward fluxes can only be found by observing the time-course of loss of radioactive ions in an inactive solution, and their absolute values can only be calculated if the true ionic content of the axoplasm is known[1,2].

This limitation has been overcome by applying the technique of activation analysis[3,4]. In principle, this consists in irradiating tissue samples with neutrons, and then determining the amounts of different radioactive isotopes which have been formed. The procedure which was adopted depended on the discovery that with invertebrate nerves—and this is probably also true of many other tissues—sodium is the only element present which gives appreciable amounts of γ-radiation after neutron irradiation; furthermore, the potassium-42 formed gives much stronger β-radiation than any other isotope likely to be found in biological material except in very small quantities. The amounts of sodium-24 and potassium-42 can therefore be determined by taking γ- and β-counts with appropriate filters, and no chemical separation of the isotopes is necessary. The only isotope which may interfere is phosphorus-32, the contribution of which to the β-count can be found by taking a further count after the short-lived sodium-24 and potassium-42 have decayed. This technique thus provides a method of determining sodium and potassium simultaneously which is rather more sensitive and much easier to perform than any of the micro-methods previously described[5].

Single 200-μ *Sepia* (cuttlefish) axons were dissected, dried, and sealed in fine quartz tubes; batches of these tubes were irradiated in the Harwell pile, together with standard samples of spectroscopically pure sodium and potassium carbonates. After irradiation, the nerves were transferred to nickel dishes, and counts were taken, first with a brass filter of 4·6 gm./cm.^{2} for γ-radiation, and then with one of 0·46 gm./cm.^{2} for potassium-42 β-radiation. When the standards had also been counted, the sodium and potassium contents could be calculated, allowance being made for the small contribution of γ-radiation from potassium-42 to the γ-count—and for β-radiation from phosphorus-32, though this was never more than a 1 per cent correction. In some samples the potassium-42 was estimated after separating it chemically, by adding inactive potassium carbonate as carrier, incinerating, precipitating potassium as the dipicrylaminate, dissolving in acetone, and counting in a liquid counter. This procedure gave a result consistently 4 per cent lower than the β-count, owing to unavoidable small losses of potassium-42 at each stage. The limiting factor in the accuracy of the experiments was the difficulty of measuring the volume and weight of single axons reliably; the radioactivity measurements had a standard error of about 2 per cent, and samples weighing as little as 0·3 mgm., containing only 0·3 μgm. of sodium and 3 μgm. of potassium, were analysed without difficulty.

The main object of the experiments was to compare the sodium and potassium contents of resting nerves with those of nerves which had been stimulated, generally at 100 impulses/sec. for 20 min., before being stored for analysis. The sodium content of the stimulated axons was found to be increased from a resting value of 40 millimol./kgm. axoplasm to about 130 millimol./kgm., while the potassium was reduced from 325 millimol./kgm. to about 245 millimol./kgm. In a series of sixteen stimulated axons, there was an average net entry of $3{\cdot}8 \times 10^{-12}$ mol. sodium/cm.^{2} membrane/impulse, and a net loss of $3{\cdot}4 \times 10^{-12}$ mol. potassium/cm.^{2}/impulse. These figures agree well with the results of tracer experiments[1,2], which can now be worked out in full, using the values for sodium and potassium concentrations obtained here. The behaviour of potassium, which moves largely outwards (about $4{\cdot}5 \times 10^{-12}$ mol. out, and only $0{\cdot}5 \times 10^{-12}$ mol. in), is in contrast with that of sodium, for which there is an appreciable turnover in addition to the net entry (10×10^{-12} mol. in, and about 5×10^{-12} mol. out).

Similar determinations of sodium and potassium were made on a few samples of axoplasm extruded from 500-μ squid axons. The resting values were 46 millimol. sodium/kgm. axoplasm and 323 milli-

mol. potassium/kgm.; during stimulation at 200 impulses/sec. there was an entry of $3 \cdot 5 \times 10^{-12}$ mol. sodium/cm.^{2}/impulse and a loss of $3 \cdot 0 \times 10^{-12}$ mol. potassium/cm.^{2}/impulse. These results provide further support for the hypothesis put forward by Hodgkin, Huxley and Katz[6,7] that during the rising phase of the nerve action potential there is a considerable increase in the permeability of the membrane to sodium.

We are indebted to the director and staff of the Marine Biological Laboratory, Plymouth, where the axons were collected, for their hospitality, and to the Atomic Energy Research Establishment, Harwell, for irradiating our samples. The expenses of the work were met by a grant from the Rockefeller Foundation.

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[1] Keynes, R. D., *J. Physiol.*, **109**, 13*P* (1949).
[2] Keynes, R. D., C.R. Colloque d'Electrophysiologie, Paris, April 1949 (in the press).
[3] Tobias, C. A., and Dunn, R. W., *Science*, **109**, 109 (1949).
[4] Brown, H., and Goldberg, E., *Science*, **109**, 347 (1949).
[5] Glick, D., "Techniques of Histo- and Cytochemistry" (Interscience Pub., New York, 1949).
[6] Hodgkin, A. L., and Katz, B., *J. Physiol.*, **108**, 37 (1949).
[7] Hodgkin, A. L., Huxley, A. F., and Katz, B., C.R. Colloque d'Electrophysiologie, Paris, April 1949 (in the press).

Determination of Neutron Densities by the Permanganate Method

Densities of slow neutrons in extended media may be measured by graphical[1] or physical[2] integration of the β-activity induced by neutron capture in a detecting element distributed in the medium. The combination of Szilard–Chalmers concentration with physical integration greatly increases the available intensity[3]. Manganese, as permanganate ion, is an eminently suitable detector[4,5]. The bulk of the induced activity is found in the manganese dioxide fraction, which is isolated by simple filtration. This activity is a measure of the average neutron density.

However, a minor, but variable, part of the activity remains with the permanganate fraction, that is, in solution ('retention'[6]). We have investigated the mechanism of the Szilard–Chalmers effect in the permanganate ion by varying the conditions of irradiation[7]. We wish to report here the part of our conclusions which may be of use to those desiring to apply the method. As a result of our investigations into the factors which determine retention, it seems that its value may be kept sufficiently constant for measurements of neutron densities to be reproducible within $\pm$ 1 per cent.

Separation of the radioactive manganese dioxide by filtration through fine paper (Schleicher–Schüll Blauband) or fine glass sinter filters (Jena *G* 4) is complete. The efficiency of this separation is not affected by the amount of manganese dioxide carrier added after irradiation, or by the amount of suspended manganese dioxide during irradiation. No appreciable part of the activity is held back by the glass walls of containers if they are washed with hydrochloric acid. Of course, it is well known that no exchange of activity between manganese dioxide and the permanganate ion occurs at room temperature[8].

Retention is independent of *p*H value between 2 and 7 (measured with glass electrode), but increases on either side of this region. Commercial potassium permanganate always contains free alkali. Phosphate buffer should be used; but at buffer concentrations greater than 10^{-2} *M*, part of the active manganese dioxide will pass through the filter as a colloid[9]. The retention decreases with decreasing concentration of permanganate ion (1·5 *M*, 17 per cent; 0·25 *M*, 12 per cent; 0·025 *M*, 6 per cent; 0·0025 *M*, 4 per cent). These values were obtained at room temperature mostly with neutral solutions of potassium permanganate; the first value was obtained with sodium or calcium permanganate, on account of its greater solubility. Retention increases steeply with temperature. Between 10° and 30° C. it rises from 10 to 16 per cent at concentration 0·22 *M*, and from 5 to 6·5 per cent at 0·03 *M*. At 0·22 *M* and 96° C. retention reaches the large value of 75 per cent.

The practical advice is, then: keep the solution (defined concentration) close to *p*H 5, use phosphate buffer 10^{-4} *M*, keep the temperature reasonably constant, filter through fine paper or glass filter, and recover manganese dioxide adsorbed by the walls with hydrochloric acid.

We wish to thank Prof. K. Przibram for his interest in our work.

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[1] Amaldi, Hafstad and Tuve, *Phys. Rev.*, **51**, 896 (1937).
[2] Booth and Hurst, *Proc. Roy. Soc.*, A, **161**, 248 (1937). Fermi, Anderson and Szilard, *Phys. Rev.*, **56**, 284 (1939).
[3] Halban, Kowarski and Magat, *C.R. Acad. Sci., Paris*, **208**, 572 (1939).
[4] Rotblat (unpublished, 1943).
[5] Broda, *J. Chim. Phys.*, **45**, 193 (1949).
[6] Libby, *J. Amer. Chem. Soc.*, **62**, 1930 (1940).
[7] Broda, Erber and Rieder, *Monatsh. Chem.* (in the press). Rieder, thesis, Vienna (1949). Erber, thesis, Vienna (1949).
[8] Polissar, *J. Amer. Chem. Soc.*, **58**, 1372 (1936).
[9] Broda and Erber, *Monatsh. Chem.*, **81**, 53 (1950).

Measurement of Appearance Potentials of Ions Produced by Electron Impact, using a Mass Spectrometer

The mass spectrometer is often used for the measurement of the appearance potentials of ions produced by electron bombardment of gaseous molecules. For this purpose, two gases are admitted to the instrument simultaneously; one is the gas under investigation, while the other is a 'standard gas' (usually argon or krypton), the ionization potential of which is accurately known from spectroscopic data. Measurements are made of the ion beam intensities as a function of electron energy, both for the ion the appearance potential of which is required and for that for which it is known. These measurements are made over a range of a few volts above the potentials at which the beams are first detected. Several rather arbitrary methods have been used for deducing the difference between the two potentials[1].

The purpose of this communication is to describe a new method of calculation which has been adopted in these Laboratories in connexion with work on dissociation processes in certain gases and the measurement of bond energies, using a Nier-type mass-spectrometer. We find that in many cases the curve relating ion-beam intensity to electron voltage

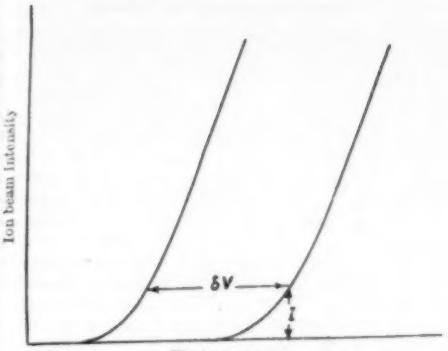

Fig. 1

is of the form shown in Fig. 1, the curved tail being asymptotic to the voltage axis. The ordinate scales are chosen so as to make the straight portions of the two curves parallel. The differences of voltage, δV, at various ordinates, I, are measured, and a graph of δV against I is drawn and extrapolated to zero beam intensity. We assume that the extrapolated value of δV is the difference between the appearance potentials. We appreciate that this procedure is quite arbitrary and that the extrapolation of any curve other than a perfectly straight line is liable to objection. However, the usefulness of the method is apparent on consideration of typical results shown in the accompanying table, obtained with argon (ionization potential 15·77 volts[2]) as the standard gas.

Gas	Ion	Ionization potential (spectroscopic) (volts)	Extrapolated ionization potential (volts)
Kr	Kr+	14·01[2]	14·01 ± 0·02
Ne	Ne+	21·57[2]	21·61 ± 0·04
O_2	O_2+	12·26[2]	12·20 ± 0·03
CO_2	CO_2+	13·79[4]	13·95 ± 0·03
CH_3CHO	CH_3CHO+	10·17[4]	10·42 ± 0·02

Two other common forms of dependence are shown in Fig. 2. Type 1 has a long straight tail AB. In type 2, the tail first rises rather steeply as shown by the portion PQ and then follows a law similar to that of type 1.

We have found various examples of ions of type 1 from halogen compounds of carbon (CCl_4, CF_2Cl_2, CF_4, etc.). Vought[5] has reported a similar result for $SiCl_3^+$ from $SiCl_4$, and attributed the tail to ions from $SiCl_2$ formed by thermal dissociation of silicon tetrachloride by the filament. It seems probable that some of our results are due to a similar cause.

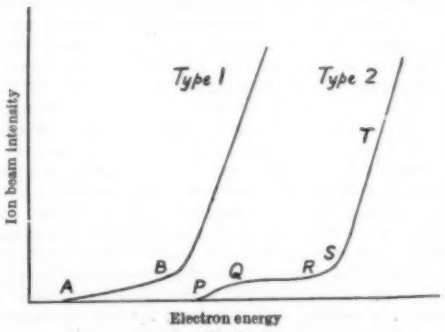

Fig. 2

Examples of ions of type 2 are $CFCl_2^+$ from $CFCl_3$ and CCl_3^+ from CCl_4. It does not seem possible to attribute these results to thermal dissociation or the presence of impurities, and we believe that in these cases the tails represent the small number of ions produced by some abnormal process. Certain of our measurements indicate that the height of this portion of the curve does not vary in proportion to the slope of the part ST on varying the electron current. We hope to publish further information on this subject elsewhere.

When graphs similar to those in Fig. 2 are obtained, we redraw the upper part of the curve, with the line AB or QR as the voltage axis. The extrapolated voltage difference is then found as before.

In addition to these two main classes, various ions have been studied which show different kinds of ionization-current *v.* electron-energy relations. These are usually ions of low relative abundance, for example, C^+ and Cl_2^+ from carbon tetrachloride, and the precise measurement of their appearance potentials is in some cases very difficult or even impossible. An approximate result can often be obtained by the method of extrapolated straight-line intercepts[1,5]. Where long flat tails are found as in Fig. 2, the intercept on the tail produced is taken instead of that on the voltage axis.

I am indebted to the Ministry of Supply (Atomic Energy Research Establishment) for the gift to the Department of the mass-spectrometer used in this work.

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[1] Honig, R. E., *J. Chem. Phys.*, **16**, No. 2, 105 (1948).
[2] Recalculated from Bacher, R. F., and Goudsmit, S., "Atomic Energy States", using the conversion factor 1 electron volt = 8067·5 cm.$^{-1}$.
[3] Recalculated from Herzberg, G., "Molecular Spectra and Molecular Structure", **1**.
[4] Sugden, Walsh and Price, *Nature*, **148**, 372 (1941).
[5] Vought, R. H., *Phys. Rev.*, **71**, 93 (1947).

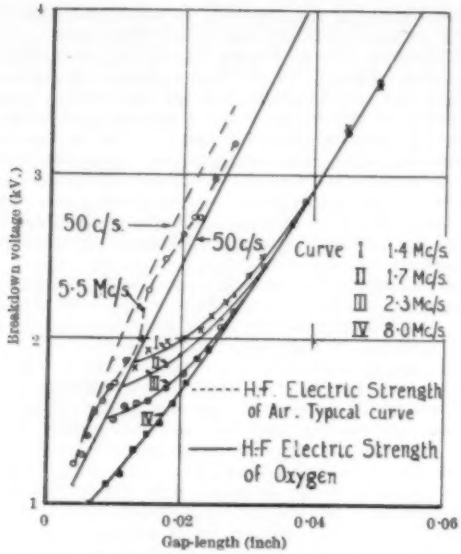
High-Frequency Discharges in Gases

Previous studies of electrical discharges in gases[1-3] at frequencies up to 10 Mc./s. have mainly been concerned with air. In recent experiments, I have measured the high-frequency electric strength of air, nitrogen, oxygen and 'Freon 12' (CCl_2F_2).

The electrodes were 2-cm. diameter chromium-plated, brass spheres, mounted in a cylindrical test-cell some 7·5 cm. in diameter. The gap was irradiated by a 1-mC. capsule of radioactive cobalt (Co^{60}), and normal precautions were taken in cleaning the electrodes. The gases were of commercial purity and were drawn into the cell through a drying chamber and dust filter.

With the exception of the tests on 'Freon 12', the scatter of results with any gas did not exceed ± 2 per cent for gap-lengths greater than 0·01 in.

The accompanying graph shows typical curves of breakdown voltage for air and oxygen plotted against gap-length at various frequencies. In air, nitrogen and oxygen there was an abrupt departure from the 50 c./s. curve obeying Paschen's Law. This 'critical point' was a function of frequency and of gap-length. The relatively large decrease in the high-frequency breakdown voltage of oxygen at gap settings greater than the critical value is of interest. The undulations



in the curve for air could always be repeated and were always observed in tests on this gas.

The electric strength of 'Freon 12' was apparently independent of frequency, which confirms and extends the work of Gänger[4] at 110 kc./s. The scatter of experimental results with 'Freon' was considerable (± 10 per cent).

The 'critical point' phenomenon may be explained in terms of the motion of positive ions which, at a certain frequency, are just able to oscillate in the gap without being swept to the electrodes. I consider that the limiting condition for such an oscillation is of the form:

$$\text{Critical frequency} = f_{crit} = \frac{AKE}{\pi\delta} = \text{const.} \times \frac{E}{\delta}. \quad (1)$$

Here E is electric field strength (V./cm.), δ is gap-length (cm.), K is positive ion mobility (cm./sec. per volt/cm.). A is a factor which allows for the slight variation of mobility at high values of E. This can be evaluated if the form of the variation is known; such data exist for positive nitrogen ions in nitrogen. Equation (1) has given good agreement with experiment, particularly for air, where the constant term was found to be 4·3 compared with the predicted 3·6.

Similar 'critical points' were found in experiments with thin wires mounted concentrically in a cylinder.

This note is based on work carried out at Queen Mary College for the Electrical Research Association, which formed the subject of a thesis for the Ph.D. degree of the University of London. A more detailed account will appear elsewhere, and the permission of the director of the Electrical Research Association to publish this communication is acknowledged.

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[1] Lassen, *Arch. Elektrotech.*, **25**, 322 (1931).
[2] Miseré, *Arch. Elecktrotech.*, **26**, 123 (1932).
[3] Luft, *Arch. Elecktrotech.*, **31**, 93 (1937).
[4] Gänger, *Arch. Elecktrotech.*, **37**, 267 (1943).

Luminescence of Silica

The luminescence associated with the wetting of finely divided solids has already been reported[1-3]. With greatly improved arrangements for heating the solid, redistilling the wetting liquid and wetting the solid in the same vacuum, it has now been found that silica from various sources heated *in vacuo* to 700° C. for a week retains some of its blue luminescence. In dry air or oxygen, heating at 650° C. or more for not less than twenty-four hours completely destroys its luminescent efficiency. Subsequent heating in pure dry hydrogen to 300° C. or above for a few minutes gives again brightly luminescent products the efficiency of which increases to a saturation value with time and temperature of heating. At room temperature hydrogen does not restore the luminescent efficiency destroyed by previous heating in air, so that presumably a chemical reaction is responsible for the effect at higher temperatures. None of the samples heated in hydrogen showed an afterglow of visibly appreciable time of decay except those heated for not more than ten minutes to 300° C. This indicates a concentration quenching of afterglow.

The luminescent emission spectra of silica wetted *in vacuo* by water, methyl alcohol, ethyl alcohol and of hydrogen-treated silica are remarkably alike, consisting of a broad band stretching from about 3500 A. to 4600 A. with maxima all at 4000 ± 70 A. The excitation spectra of the hydrogen-treated silica, obtained by a photo-electric method, with calibration of and allowance for the source distribution, shows one relatively narrow and intense band stretching from about 2400 A. to 2900 A. with a sharp peak at about 2650 A. and a quantum efficiency about twice that of vacuum oil, and some very minor bands with peaks at about 3170 A. and 3350 A.

These new results support the view expressed previously[3] that the carrier of the luminescence of silica wetted by molecules containing hydroxyl radicals is that radical. It is now suggested that in the hydrogen-treated silica, after partial reduction of the silica,

$$SiO_2 + H_2 \rightarrow SiO + H_2O,$$

the silicon monoxide or oxygen deficits formed in the silica lattice function as active sites for the adsorption of the water formed in the reaction. There is a good deal of evidence for the production, at least temporarily, of silicon monoxide, and some for its stability, when associated with silica or iron[4-6]. In view of this and the evidence reported above, it seemed desirable to investigate the matter further from the luminescent aspect. Using the vacuum apparatus referred to, an intimate mixture of silicon and of silica which had previously had its luminescent power destroyed by heating in dry air was heated for some hours at 400° C. *in vacuo* (10^{-6} mm.) so as to remove any remaining traces of water without appreciable oxidation of the silicon. Absence of luminescence was checked. The mixture was then heated *in vacuo* to 1,250° C. for an hour. On cooling and sealing off it was found that rings of material of varying colours had sublimed along the tube. These rings showed luminescence of varying colour and time-decay of afterglow. Micro-analyses of the rings suggest that the SiO formed in the reaction $SiO_2 + Si \rightarrow 2SiO$ has sublimed to the cooler parts of the tube and, after partial decomposition ($2SiO \rightarrow SiO_2 + Si$), determined in extent by the temperature and temperature gradient, has formed solid solutions

of silicon, silicon monoxide and silica (richest in silicon at the cooler end and in silica at the hotter end) and that the varying luminescence is an indication of the varying composition. Further indication of a chemical reaction ($SiO_2 \rightarrow O + SiO$) has been obtained by heating silica in which the luminescence had been destroyed by previous heating in air *in vacuo* for one hour at 1,250° C. A marked luminescent efficiency is developed which is attributable to the formation of a solid solution of silicon monoxide in silica, or to the development of oxygen deficits in the silica lattice.

I would like to express my gratitude to Mr. R. F. Youell for the micro-analyses and much valuable help, to the Leverhulme Fellowship Fund for a personal grant, to the Royal Society for an apparatus grant and to the Department of Scientific and Industrial Research for a grant which has enabled me to make use of the help of Mr. C. N. Heap in the work.

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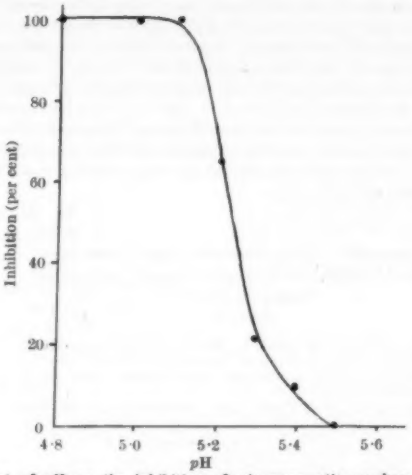
[1] Ewles, *Nature*, **125**, 706 (1930).
[2] Ewles and Martin, *Proc. Leeds Phil. Soc.*, Pt. X, 557 (1939).
[3] Ewles and Farnell, *Proc. Phys. Soc.*, A, **62**, 216 (1949).
[4] Zappfe and Sims, *Chem. Abs.*, 3129 (1942). Zappfe, *J. Amer. Ceram. Soc.*, **27**, 293 (1944).
[5] Ziutl, Brauning, Grube, Krings and Morawietz, *A. Anorg. Chem.*, **245**, 1 (1940).
[6] Welch, Ann. Rep. Chem. Soc., **42**, 87, 88 (1945).

Isoelectric Points of Enzymes as Determined by Inhibition with Suramin

In the course of a study of the action of suramin on a variety of enzymes, we have found that the enzymes which are inhibited by this trypanocidal drug can be divided into two groups[1]. Group *A* contains a few enzymes, for example, hexokinase, succinic dehydrogenase and choline dehydrogenase, which are strongly inhibited by suramin at *p*H 7·4. Group *B*, a considerably larger group, contains enzymes which are unaffected by suramin at *p*H 7·4 but are strongly inhibited in acid solution. Urease, for example, is inhibited by $0{\cdot}33 \times 10^{-3}$ *M* suramin to the extent of 100, 50 and 0 per cent at *p*H's 5·0, 5·1 and 5·3 respectively. This change from complete to zero inhibition occurs at about the isoelectric point of urease, and as we obtained inhibition *v.* *p*H curves of the same type with pig pancreatic amylase (cf. graph) and a few other enzymes, we decided to study the possible use of this phenomenon for the determination of enzyme isoelectric points.

Since we believe that the method is one which might prove helpful to many investigators, a few general details are given here, but a more complete account will be given elsewhere[2]. Samples of the enzyme solution are buffered at the required *p*H, and a small amount of a suramin solution is added to each. The mixtures are kept at room temperature for 20–30 min., and the enzymic activity of each mixture is then determined and compared with that of a suitable control. Where the method is applicable, the best results are usually obtained with a suramin concentration of about 10^{-3} *M*, but much less suramin is required with purified enzymes; sufficient should be used, however, to give a sharp drop in the inhibition *v* *p*H curve. The fall from 100 per cent to zero inhibition usually occurs over a range of 0·2–0·5, and sometimes 0·2–0·3, of a *p*H unit, and the



Effect of *p*H on the inhibition of pig pancreatic amylase by suramin

mid-point of this range can be regarded as the mean isoelectric point of the enzyme molecules.

The methods usually used for the determination of enzyme isoelectric points are complicated and tedious. They require a pure preparation of the enzyme and expensive equipment such as the electrophoresis apparatus of Tiselius; it is not surprising, therefore, that relatively few reliable values for enzyme isoelectric points are recorded in the literature. Where these are available, however, there is usually very good agreement between the values we have obtained by the 'suramin-inhibition' method and those given in the literature. So far, we have obtained values for sixteen enzymes, and a few typical results and the corresponding values recorded in the literature are given in the accompanying table.

Some Enzyme Isoelectric Points

Enzyme	Isoelectric point	
	By the suramin-inhibition method	Recorded in the literature
Urease	5·1	5·0*
Carbonic anhydrase (ox blood)	5·2–5·4	5·2–5·4†
Carbonic anhydrase (sheep blood)	6·0–6·4	
Amylase (human saliva)	5·3	5·0–5·5‡

* Sumner, J. B., and Hand, D. B., *J. Amer. Chem. Soc.*, **51**, 1255 (1929).
† Peterman, M. L., and Hakala, N. V., *J. Biol. Chem.*, **145**, 701 (1942).
‡ "Very probable value" (private communication from Prof. K. H. Meyer, University of Geneva).

This new method cannot be used for all enzymes, for some are unaffected by suramin in the *p*H-range over which they act, and some are unstable at their isoelectric points. Where it is applicable, however, the method has many advantages over other available methods. It is simple and rapid, and, above all, it can be carried out with crude enzyme preparations.

The inhibition of our group *B* enzymes by suramin is most probably due to the interaction of the naphthylamine-trisulphonic acid groups of the drug with basic groups in the region of the active centres of the enzyme. Thus one might expect that many acid dyes will behave like suramin in this respect, and, indeed, Quastel and Yates[3], in experiments with invertase treated with various acid dyes, have obtained inhibition *v.* *p*H curves of the sigmoid type.

With most of the acid dyes they tested, however, the curves did not fall as sharply as do those we have obtained with suramin. In preliminary experiments we have found that heparin, which is a complex polysaccharide containing ester sulphate groups, also gives a similar inhibition *v.* *p*H curve with urease.

We are grateful to the Medical Research Council for a grant covering the expenses of this investigation, and to Miss Barbara Hume for help with some of the enzyme experiments.

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[1] Wills, E. D., and Wormall, A., *Biochem. J.*, **44**, xxxix (1949). Town, B. W., Wills, E. D., and Wormall, A., *Nature*, **163**, 735 (1949).
[2] Wills, E. D., and Wormall, A. (in the press). Wills, E. D. (in the press).
[3] Quastel, J. H., and Yates, E. D., *Enzymologia*, **1**, 60 (1936).

Simultaneous Fixation of Trioses, Pyruvic Acid and Acetaldehyde from Alcoholic Fermentation with Living Cells

The process for fixation of the intermediate products of alcoholic fermentation by living cells, discovered by Neuberg with the aid of bisulphite, has limitations on account of the toxicity and low power of the salt. Semicarbazide, dimedone and hydrazine are of no more use than bisulphite. But, by the aid of bisulphite, it has been possible to obtain useful results on some fundamental aspects of certain biological processes.

More interesting in view of the fixation of intermediate ketonic or aldehydic products seems to be phenylhydrazine oxalate,

$$\begin{matrix} COOH.H_2N—NHC_6H_5 \\ | \\ COOH.H_2N—NHC_6H_5 \end{matrix}$$

which I have used to investigate some processes of microbial dissimilation of carbohydrates, obtaining positive results that are more significant as they have been obtained in physiological conditions, that is, with living cells. The toxicity of this substance at concentrations of 0·1–0·2 per cent is slight to many microbes and allows them to maintain their regular activity.

The following account, the first of a series, submits the results obtained in alcoholic fermentation, a well-known process and particularly suitable for demonstrating the fixing power of phenylhydrazine oxalate. From saccharose fermentations by *Saccharomyces cerevisiæ*, the simultaneous fixation as phenylhydrazones of the trioses, pyruvic acid and acetaldehyde was possible. It was only very recently that trioses were discovered by other methods by Kiessling[2] in alcoholic fermentations with living cells.

The medium consisted of 2 per cent saccharose, 0·15 per cent phenylhydrazine oxalate, 1·5–2·5 per cent wet yeast, 90 ml. distilled water and 10 ml. yeast water. The oxalate was dissolved in boiling water, and then saccharose added at low temperature; finally yeast was suspended in the solution. At 30° the fermentation lasted six to ten hours. The medium was centrifuged and the clear liquor analysed for fixed products.

Acetaldehyde was determined by distillation of the medium with pyruvic acid in a Vigreux column and precipitation in the distillate as 2,4-dinitrophenylhydrazone.

The product after three recrystallizations from alcohol has melting point 163°; found, C, 42·80; H, 3·70; N, 24·94; calc., C, 42·88; H, 3·57; N, 25·00 per cent; amount produced, 0·0035 gm.–0·02 per cent (as 2,4-dinitrophenylhydrazone).

Pyruvic acid was crystallized out as the phenylhydrazone by vacuum concentration of the medium, from which it can be also readily extracted by ether. After crystallization it is dissolved in alkali, precipitated by acidification with dilute hydrochloric acid and further purified by recrystallization from alcohol. The product has melting point 190°; found, C, 60·80; H, 5·90; N, 15·71; calc., C, 60·68; H, 5·62; N, 15·73 per cent; amount produced, 0·013 gm.–0·037 per cent (as phenylhydrazone).

Trioses. A direct precipitation of trioses as phenylhydrazones or 2,4-dinitrophenylhydrazones was impossible, so the determination was accomplished by the method of Neuberg and co-workers[3] by conversion of trioses to methylglyoxal, distilling the medium, previously treated with benzaldehyde, with sulphuric acid of concentration exceeding 20 per cent. Methylglyoxal is precipitated as 2,4-dinitrophenylhydrazone and this is purified by dissolving in nitrobenzene and precipitating with alcohol. The product has melting point 298°; found, C, 41·78; H, 2·98; N, 25·88; calc., C, 41·64; H, 2·77; N, 25·93 per cent; amount produced 0·011 gm.–0·023 per cent (as 2,4-dinitrophenylhydrazone).

The presence in the medium of trioses is shown by the fact that on distillation without sulphuric acid the distillate contains but traces of methylglyoxal.

At the end of the experiment the vitality of the yeast was shown by its normal development on the same medium without phenylhydrazine oxalate.

In these experiments no attention was given to the problem of phosphorylation; that will be the subject of a further investigation.

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[1] "Beilstein", **15**, 109 and 26.
[2] Kiessling, W., *Indust. Agric. et Alim.*, **66**, 111 (1949).
[3] Neuberg, C., Färber, E., Levite, A., and Schwenck, E., *Biochem. Z.*, **83**, 263 (1917).

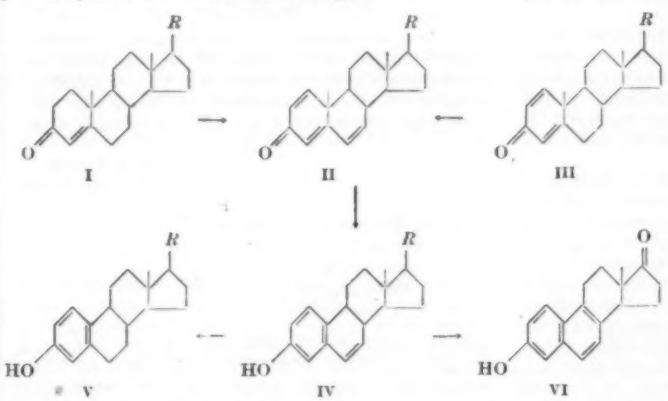
Bromination of Certain Ketosteroids and a Partial Synthesis of Œstradiol, Œstrone and Equilenin

It has been claimed repeatedly in the literature[1] that the conversion of a Δ^4-3-ketosteroid (I), for example, testosterone, into a phenol (V), for example, œstradiol, is impossible, because mono- and polybromination of (I) leads to compounds possessing halogen atoms in position 4 and in ring *B*. A reinvestigation of this problem has proved the earlier work in error, and has provided a facile partial synthesis for all of the major, naturally occurring œstrogens.

Dibromination of testosterone acetate (I, R=OAc) in ether–acetic acid or with two moles of N-bromosuccinimide in carbon tetrachloride solution gave a dibromo derivative which was smoothly dehydrobrominated with collidine with loss of *two moles* of hydrogen bromide to afford $\Delta^{1,4,6}$-androstatrien-17-ol-3-one 17-acetate (II, R=OAc) (m.p. 151–153°, $[\alpha]_D^{20}$ −9° (chloroform), ultra-violet absorption max-

ima at 222, 256 and 298 mμ). The structure of the trienone was proved unequivocally by an independent synthesis from the dienone III via the 6-bromo derivative (prepared with N-bromosuccinimide) and thence collidine treatment. Identical procedures in the case of Δ^4-androstene-3,17-dione (I, $R = O$) led to $\Delta^{1,4,6}$-androstatriene-3,17-dione (V, $R = O$) (m.p. 165–166°, $[\alpha]_D^{20} + 72{\cdot}5°$ (dioxane), ultra-violet absorption maxima at 222, 256 and 298 mμ), and with Δ^4-cholesten-3-one (I, $R = C_8H_{17}$) to $\Delta^{1,4,6}$-cholestatrien-3-one (II, $R = C_8H_{17}$, m.p. 82–83°, $[\alpha]_D^{20}$ 0° (chloroform), ultra-violet absorption maxima at 224, 258 and 300 mμ). This reaction, apparently a general one for Δ^4-3-ketosteroids, can be rationalized only if one assumes the formation of a 2,6-dibromo-Δ^4-3-ketosteroid or an *in situ* rearrangement to such a structure, and thus necessitates revision of a considerable number of structures postulated earlier[1].

Aromatization of mineral oil solutions of the trienones II (R=OAc or O) in the vapour phase at 600° by the general procedure of Inhoffen[2] gave in *c.* 40 per cent yield Δ^6-dehydro-œstradiol 17-monoacetate (IV, R=OAc, m.p. 251–253°, $[\alpha]_D^{20} -203°$ (chloroform) and Δ^6-dehydroœstrone (IV, R=O, m.p. 261–263°, $[\alpha]_D^{20} -127°$ (dioxane), acetate, m.p. 140·5°, benzoate, m.p. 202°), which were smoothly hydrogenated to œstradiol (V, R=OH) and œstrone (V, R=O) respectively. Finally, Δ^6-dehydroœstrone acetate on fifteen minutes treatment with selenium dioxide in acetic acid solution readily afforded equilenin acetate (m.p. 156–158°, $[\alpha]_D^{20} + 72°$ (chloroform)) and, on saponification, equilenin (VI, m.p. 256–258°, $[\alpha]_D^{20} + 86°$ (dioxane)) identical (including spectrum) with the natural hormone. This represents the first partial synthesis of equilenin from a non-aromatic steroid, while the preparation of œstrone and œstradiol from Δ^4-3-ketosteroids constitutes a novel, and in several respects preferable, alternate partial synthesis of the other œstrogens.



A Δ^6-dehydroœstrone described in the literature[3] agrees in all its properties (including biological activity and ultra-violet spectrum) with our substance, with the exception of the rotation, for which a value of $[\alpha]_D + 150°$ (dioxane) was reported. Dr. O. Wintersteiner, with whom we communicated, has indicated that the positive rotation published earlier[3] was most likely in error, as pointed out in the accompanying note[4]. The strongly negative rotation of all our Δ^6-dehydroœstrogens (V, R=OH, OAc, O) gave an average $[\Delta]M_D$ contribution of −754 for the 6,7-double bond, qualitatively quite similar to that observed recently[5] for Δ^6-stenols of the cholestane series. The above transformations, which do not involve hydroxylation at C−8 [5], further confirm the postulate[6] that œstrone and equilenin possess the same configuration at carbon atoms 13 and 14.

A detailed account of these and related investigations will be published elsewhere in the near future.

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[1] Butenandt, A., Schramm, G., and Kudsus, H., *Ann.*, **531**, 176 (1937); Inhoffen, H. H., *Angew. Chem.*, **59**, 207 (1947) and references cited therein.

[2] Cf. Inhoffen, H. H. (ref. 1). Fiat Report No. 996 (London: H.M. Stationery Office, 1947). Djerassi, C., and Scholz, C. R., *J. Amer. Chem. Soc.*, **71**, 3962 (1949); Wilds, A. L., and Djerassi, C., *ibid.*, **68**, 2125 (1946). Hershberg, Rubin and Schwenk, *J. Org. Chem.* (in the press).

[3] Pearlman, W. H., and Wintersteiner, O., *J. Biol. Chem.*, **132**, 605 (1940).

[4] Pearlman, W. H., and Wintersteiner, O. (see following letter).

[5] Barton, D. H. R., and Rosenfelder, W. J., *Nature*, **164**, 316 (1949). Wintersteiner, O., and Moore, M., *ibid.*, **164**, 317 (1949).

[6] Shoppee, C. W., *Nature*, **161**, 207 (1948); Klyne, W., *ibid.*, **161**, 434 (1948).

Rotation of Δ^6-*iso*Equilin (6-Dehydroœstrone): a Correction

In 1940 we described the conversion of equilin, through 7-ketoœstrone, 7-hydroxyœstrone and 7-chloroœstrone, to its Δ^6 double bond isomer[1]. The specific rotation $[\alpha]_D^{24}$ of this compound was then reported by us as +150° (in dioxane). Dr. St. Kaufmann, of Syntex, S.A., has kindly directed our attention to the widely divergent value (−127°) given by an otherwise apparently identical preparation obtained in that Laboratory from Δ^4-androstenedione (cf. preceding communication by Rosenkranz *et al.*). A check determination now carried out on a small reference sample of Δ^6-*iso*-equilin still in our possession gave −120°, in fair agreement with the value of Rosenkranz *et al.* This preparation (m.p. 258–261°, corr.) did not depress the melting point of a specimen of 6-dehydroœstrone obtained from Dr. Kaufmann which in our hands melted at 257–260°; likewise, the melting point of a mixture of the respective 3-benzoates (m.p. 201°, 200°) was not depressed. It is clear, therefore, that the positive rotation figure originally recorded by us was in error, and that the two compounds in question are identical in every respect.

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[1] Pearlman, W. H., and Wintersteiner, O., *J. Biol. Chem.*, **132**, 605 (1940).

Configuration of the *C/D* Ring Junction in Equilenin and Other Steroids

THE configuration of the *C/D* ring fusion in equilenin has been the subject of a number of communications[1–3]. We consider that the arguments advanced for a *trans* ring junction leave much to be desired. Shoppee's[1] conclusion that the dehydrogenation of equilin to equilenin under mild conditions proves the steric identity of the *C/D* union in these two substances can no longer be accepted, since *iso*equilin, which is now known[4,5] to be also *trans*, gives *iso*equilenin (which has the opposite *C/D* configuration to equilenin) under the same conditions[6].

It is evident that the same uncertainty is present in any correlation based on the formation of equilenin (or *iso*equilenin) by reactions involving a centre adjacent to C_{14}[2]. One would anticipate epimerization at C_{14} in some of these experiments because of the possibility offered of relieving the strain associated with the *trans* *C/D* hydrindane system.

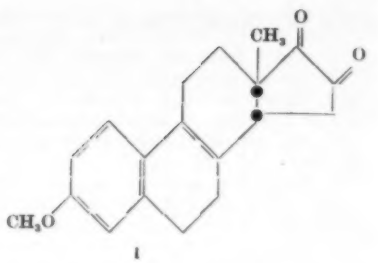
Another attempt to correlate the *C/D* configuration of equilenin with that of other natural steroids through a determination of the configuration at C_{14} was based on the use of the method of molecular rotation differences[3]. Since this centre is adjacent to an unsaturated system which might give rise to considerable 'vicinal effect'[7], the validity of this conclusion is questionable.

An unambiguous proof of the configuration of equilenin follows from the fact that Bachmann's[8] α-7-methoxy-2-methyl-2-carboxy-1,2,3,4 tetrahydrophenanthrene-1-acetic acid (III) (which was converted to *iso*equilenin) is obtained[5] by hydrogen peroxide cleavage of the α-diketone (I) to the diacid (II), followed by dehydrogenation. The diketone I is one of the products of the Diels–Alder reaction between 1-vinyl-6-methoxy-3,4-dihydronaphthalene and 3-methyl-*cyclo*pentene-1,2-dione[9,5], and must therefore be *cis*.

Dehydrogenation of II would not be expected to invert C_1 (C_{14} sterol numbering), since the strain associated with a *trans* hydrindane system is no longer present. Dehydrogenation experiments in the doisynolic acid series confirm this view[10]. The *C/D* ring junction is therefore *cis* in *iso*equilenin and *trans* in equilenin.

Compound II proved identical with a diacid prepared by Miescher *et al.*[2]. This diacid, which is therefore unambiguously *cis*, gave after homologation and ring closure a substance which was *not* *dl-iso*equilin. *Iso*equilin is therefore *trans*, and its formation from equilin by acid isomerization cannot involve epimerization at C_{14} (which would have produced a *cis* compound). This means that the *C/D* junction in œstrone must then also be *trans*, since it follows from the work of Pearlman and Wintersteiner[11] that this junction is the same as that of equilin.

This derivation of the *trans* *C/D* junction in œstrone can be used as chemical evidence for the *trans* *C/D* union in the non-aromatic steroids, since cholesterol can be degraded to œstrone by a reaction which, although a pyrolysis, cannot involve C_{14}[12,13]. This evidence is more convincing than that of Wieland and Dane[14], which is open to serious criticism[15], or that of Dimroth and Jonsson[16], which logically demonstrates only the fact that vitamin D_2 has a *C/D* *trans* union, because the identity of the *C/D* junction in vitamin D_2 and ergosterol has not been convincingly demonstrated. It was possible that the *trans* *C/D* vitamin D_2 had resulted from the irradiation of a *cis* *C/D* ergosterol. Such a change to the less stable configuration is known[17] to take place when *iso*dehydrocholesterol, which is a C_8 α-compound, is transformed during irradiation to the C_8 β-configuration, which contains the less stable *cis*-decalin system.



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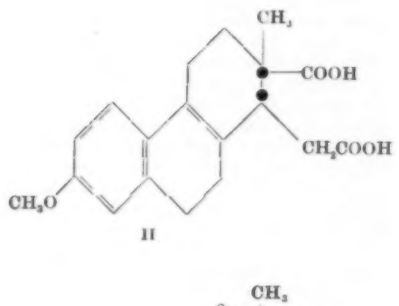

II

III

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[1] Shoppee, *Nature*, **161**, 207 (1948).
[2] Rosenkranz, Djerassi, Kaufmann, Pataki and Romo, *Nature*, p. 814 of this issue.
[3] Klyne, *Nature*, **161**, 434 (1948).
[4] Heer, and Miescher, *Helv. Chim. Acta*, **31**, 1289 (1948).
[5] Singh, G., *J. Amer. Chem. Soc.* (in the press).
[6] Hirschmann, H., and Wintersteiner, *J. Biol. Chem.*, **126**, 737 (1938).
[7] Barton, *J. Chem. Soc.*, 783 (1948).
[8] Bachmann, Cole and Wilds, *J. Amer. Chem. Soc.*, **62**, 824 (1940).
[9] Dane and Schmitt, *Ann.*, **537**, 246 (1939).
[10] See, for example, Anner and Miescher, *Helv. Chim. Acta*, **30**, 1422 (1947).
[11] Pearlman and Wintersteiner, *J. Biol. Chem.*, **130**, 35 (1939); 132, 605 (1940).
[12] Inhoffen and Zühlsdorff, *Ber.*, **74**, 1911 (1941).
[13] Wilds and Djerassi, *J. Amer. Chem. Soc.*, **68**, 2125 (1946).
[14] Wieland and Dane, *Z. Physiol. Chem.*, **216**, 91 (1933).
[15] Peak, *Nature*, **140**, 280 (1937).
[16] Dimroth and Jonsson, *Ber.*, **74**, 5201 (1941).
[17] Windaus and Zühlsdorff, *Ann.*, **536**, 209 (1938).

Interaction of Arylthioureas and Aromatic Sulphonyl Chlorides

It was recently shown[1] that the reaction of arylureas and aromatic sulphonyl chlorides in pyridine under restrained conditions does not yield arylsulphonyl arylureas but occurs with simultaneous dehydration, and results in the formation of arylsulphonyl arylcyanamides in good yields. The production of the appropriate substituted melamines was also observed in some cases[2]. In continuation of this work, the interaction of sulphonyl chlorides and arylthioureas has been examined.

The action of benzenesulphonyl chloride on thiourea in alcoholic solution was first studied by Remsen and Turner[3], who obtained dithioformamidine dihydrochloride and diphenyl disulphoxide; similar results were obtained by Leitch *et al.*[4] using *p*-acetamidobenzenesulphonyl chloride. Fromm and Heyder's attempts[5] to prepare the corresponding aryl-substituted dithioformamidine by the action of sulphonyl chlorides on phenylthiourea resulted in ring-closure, with formation of 2 : 4-diphenyl-3 : 5 di-imino-2 : 3 : 4 : 5-tetrahydro-1 : 2 : 4-thiadiazole.

In the present investigation, using conditions recently employed with arylureas, the interaction of arylthioureas and aromatic sulphonyl chlorides was found to take a different course. The aromatic thiourea is rapidly desulphurized giving arylcyanamide as one of the main products, and the reaction then proceeds essentially as with arylureas[1]. Thus, treatment of 1 mole of arylthiourea with 2·5 moles of sulphonyl chloride in pyridine at moderate temperatures gives a product from which approximately 1 gm.-molecule each of arylcyanamide (I) and sulphur are obtained. Some of the cyanamide reacts further with the excess of sulphonyl chloride, as shown by the isolation of arylsulphonyl arylcyanamide (II). Part of the sulphonyl chloride is converted to the disulphoxide (III) during the reaction.

Disregarding, for the time being, the mechanism of the reaction, the net results can be represented by the following overall equation:

$$3\,R.NH.C(SH):NH + 3\,R'.SO_2Cl \longrightarrow \underset{\text{(I)}}{3\,R.NH.CN} + 3\,S + \underset{\text{(III)}}{R'.SO.SO.R'} + R'.SO_2OH + 3\,HCl + H_2O$$

$$\text{(I)} \xrightarrow{R'SO_2Cl} \underset{\text{(II)}}{R'.SO_2.NR.CN}$$

As an example, the interaction between phenylthiourea and toluene-*p*-sulphonyl chloride gave phenylcyanamide (65 per cent yield), sulphur (80 per cent, based on the thiourea), toluene-*p*-sulphonyl phenylcyanamide (25 per cent) and di-*p*-toluene disulphoxide (25 per cent). Similar results are obtainable with other arylthioureas.

Further experiments in connexion with this work are in progress, and a detailed account will appear elsewhere in due course.

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[1] Kurzer, *J. Chem. Soc.*, 1034, 3029 (1949).
[2] Kurzer, *J. Chem. Soc.*, 3033 (1949).
[3] Remsen and Turner, *Amer. Chem. J.*, **25**, 190 (1901).
[4] Leitch, Baker and Brickman, *Canad. J. Res.*, **23** B, 139 (1945).
[5] Fromm and Heyder, *Berichte*, **42**, 3804 (1909).

Structure of the Diazonium Ion

According to the accepted constitution of the diazonium ion, a nitrogen atom takes the place of three hydrogen atoms in a substituted ammonium ion. It is accordingly conceivable that there may be resonance between the two forms:

I II

By labelling one of the nitrogen atoms, we have shown that such resonance does not, in fact, occur.

Starting with phthalimide containing labelled nitrogen, we synthesized and diazotized labelled aniline and coupled it with β-naphthol. By reduction we split the product to aniline and α-amino-β-naphthol. If resonance of the above kind exists, the labelled nitrogen should be equally divided between the aniline and the amino-naphthol. If, on the other hand, such resonance is absent, the labelled nitrogen should be entirely in the aniline. According to our preliminary results, more than 97 per cent of the labelled nitrogen remains in the aniline. We conclude that there is no resonance.

We are indebted to the Mass Spectrometer Group, Atomic Energy Research Establishment, Harwell, who assayed our nitrogen samples.

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The Reaction between β-Carotene and Antimony Trichloride

It has always seemed anomalous that anhydrovitamin A with six conjugated double bonds should give λ_{max} at 620 mμ with the Carr–Price reagent, and that β-carotene with eleven conjugated double bonds should give λ_{max} at 585 mμ. Further, ε_{max} for anhydrovitamin A is 170,000, whereas that for β-carotene at 585 mμ is only 22,000 [1].

Assuming that the compounds formed in the reaction are unsymmetrical ions, λ_{max} should be a linear function of the number of conjugated double bonds[2]. In the colour test, anhydrovitamin A_1 (with six conjugated double bonds) has $\lambda_{max} = 623$ mμ[3], whereas anhydrovitamin A_2 (with probably seven conjugated double bonds) has $\lambda_{max} = 693$ mμ[4]. Hence for eleven conjugated double bonds one would expect $\lambda_{max} = 693 + 4\,(693 - 623) = 973$ mμ. Also, axerophthene (five conjugated double bonds) has $\lambda_{max} = 577$ mμ[5] in the colour test and *iso*-desmethylaxerophthene (four conjugated double bonds) has $\lambda_{max} = 490$ mμ[6]. Hence for eleven conjugated double bonds one would expect $\lambda_{max} = 577 + 6\,(577 - 490) = 1{,}099$ mμ. The assumptions here debar quantitative prediction, but they prompt investigation in the region

1 μ. The purpose of this communication is to report the result of a re-examination of the reaction of β-carotene and antimony trichloride.

The sample of β-carotene used had the following characteristics: m.p. 179°; in light petroleum (b.p. 70–80°) the maxima were at 478 mμ and 451 mμ, $E^{1\ per\ cent}_{1\ cm.}$ (451 mμ), 2,500 and $E^{1\ per\ cent}_{1\ cm.}$ (340 mμ), 136, and in carbon disulphide the maxima were at 512 mμ and 482 mμ. The sample probably contained some *cis*-isomers. 1 ml. of a solution of β-carotene in chloroform was mixed with about 2 ml. of Carr–Price reagent and the absorption measured at one wavelength in a Beckmann spectrophotometer. It was found that the absorption reached a value which remained approximately the same for about 1 min., 45 sec. after mixing. The value of the extinction 60 sec. after mixing was recorded for a number of wave-lengths using separate solutions for each wavelength. In this manner it has been shown that λ_{max} is about 1,020 mμ and that ε_{max} is about 115,000. Antimony trichloride is transparent in this region of the spectrum.

F. D. Collins

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Jan. 18.

[1] Morton, R. A., "Absorption Spectra" (Adam Hilger, Ltd., London, 1942).
[2] Ferguson, L. N., *Chem. Rev.*, **43**, 385 (1948).
[3] Karrer, P., and Schwyzer, R., *Helv. Chim. Acta*, **31**, 1055 (1948).
[4] Shantz, E. M., *Science*, **108**, 417 (1948).
[5] Karrer, P., and Benz, J., *Helv. Chim. Acta*, **32**, 232 (1949).
[6] Karrer, P., Karanth, K. P., and Benz, J., *Helv. Chim. Acta*, **32**, 1036 (1949).

A Method for the Determination of Procaine Penicillin

The iodimetric estimation of procaine penicillin presents difficulties because of the interaction of procaine with iodine. Sodium penicillin to which an equivalent weight of procaine hydrochloride has been added gives results which may be from 3 to 5 per cent lower than for the untreated penicillin. Although the ferricyanide method of Hiscox[1] is said to be free from the above objection, we could not obtain consistent results with it, a spread of ± 4 per cent being obtained in a series of determinations on a sample of *sodium* penicillin. The removal of the procaine ion by precipitation followed by iodimetric determination of the penicillin seemed the most promising line of attack, and sodium silicomolybdate and sodium silicotungstate were both found suitable for this purpose, although the latter possesses certain advantages over the former and is obtainable commercially. Both substances give with procaine salts heavy precipitates which are granular in the presence of sodium chloride (3 per cent) and can readily be centrifuged to a compact mass permitting decantation of the supernatant liquid. Precipitation is virtually complete, and neither precipitant has any action upon iodine or penicillin.

Results obtained by adding procaine hydrochloride to sodium penicillin and assaying iodimetrically after precipitation were about 0·5 per cent higher than for the untreated sodium penicillin. This difference, which may be real, is nevertheless well within the accepted limits of experimental error of the two different iodimetric methods which were employed for the estimations[2,3]. For the first method[2], results for sodium penicillin ranged from 98·3 to 100·8 per cent with a mean value of 99·5 per cent and standard deviation of 0·30, while for procaine penicillin the corresponding figures were 98·7–101·3 per cent with a mean figure of 99·95 per cent and standard deviation of 0·36. For the second iodimetric method[3] the results for sodium penicillin ranged from 98·6 to 99·9 per cent with a mean value of 99·35 per cent and standard deviation of 0·17, and for procaine penicillin from 99·5 to 100·3 per cent with a mean value of 100·0 per cent and standard deviation of 0·18.

Full details of the work carried out in connexion with the above will be published elsewhere at the earliest opportunity.

Thanks are due to the Chief Scientist, Ministry of Supply, for permission to publish this note.

A. M. Wild

Chemical Inspectorate,
Ministry of Supply.
Jan. 18.

[1] Hiscox, D. J., *Anal. Chem.*, **21**, 658 (1949).
[2] Wild, A. M., *J. Soc. Chem. Indust.*, **67**, 90 (1948).
[3] Report of the Analysts Sub-Committee to the Ministry of Health Conference on the Differential Assay of Penicillin, Part II. *Analyst*, **74**, 550 (1949) (with modifications).

Mercerization of Jute

The transformation of crystalline native cellulose (cellulose-I) into the hydrate modification (cellulose-II) by the action of caustic soda solutions is known to proceed by the formation of intermediate crystalline soda-cellulose complexes[1]. In a previous publication[2] from this Laboratory, it was reported that the complete native-hydrate transformation is impossible in raw jute, the presence of appreciable quantities of cellulose-I being always apparent from the X-ray photographs. In ramie the conditions for a partial transformation of this kind are much more critical, and appear to be such that only part of the cellulose has reacted with the alkali. In order to determine whether the effect in jute can also be explained in this way, we have studied the 'soda-cellulose' obtained by treating raw jute without tension in caustic soda solutions of various concentrations, and find that in general the native modification is absent for concentrations greater than about 10 per cent (w/w), but that it reappears when the alkali is removed by washing in water. In jute, therefore, incomplete transformation to cellulose-II is not due to the failure of the alkali to penetrate into the cellulose crystallites, but to at least partial reversibility of the native → soda-cellulose reaction.

We have ascribed the difference in behaviour of jute and ramie during mercerization to the effect of lignin in the former, where, perhaps by forming cross-linkages between the cellulose chains near the boundaries of the crystallites, it introduces an element of stability absent in the purer fibres. In this connexion we should also like to direct attention to an abnormal soda-cellulose-I which appears in jute treated with 10 per cent caustic soda solution. The X-ray photograph is then that of soda-cellulose-I with the strong inner equatorial reflexion spread out into a streak, indicating either a distortion of the soda-cellulose lattice or the co-existence of a range of transitional states between native cellulose and soda-cellulose-I in jute. This effect has not, so far as we know, been

observed in other cellulose fibres, and in jute is only seen for a narrow range of concentrations of the alkali. It may, of course, also be a consequence of extra-crystallite cellulose-lignin linkages.

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University of Leeds.
Jan. 13.

[1] Hess *et al.*, *Z. phys. Chem.*, B **4**, 321 (1929); B **11**, 381 (1931); B **43**, 309 (1939).
[2] Sen and Woods, *Biochim. et Biophys. Acta*, **3**, 510 (1949).

Davyum, a Possible Precursor of Rhenium (Element 75)

ON June 28, 1877, the Russian chemist, Kern, claimed[1] to have discovered a new element in platinum residues. A solution left after the removal of platinum, iridium and rhodium was concentrated with ammonium chloride and nitrate and gave a dark red precipitate. On ignition, this left a grey spongy mass that fused in the oxyhydrogen flame to a silvery ingot of a new metal which Kern called 'davyum' (Da), as he himself says, in honour of the great English chemist. Only 0·27 gm. of davyum was obtained and its density was given as 9·385 at 25° C.

Kern assumed its solution in *aqua regia* contained davyum chloride. With potassium hydroxide it gave a light yellow precipitate, soluble in acids. Hydrogen sulphide gave a brown precipitate that turned black. Potassium thiocyanate gave a red colour (or precipitate if heated). Later, Kern reaffirmed these results and mentioned others—formation of a double salt with potassium cyanide, a brown precipitate with the ferrocyanide and the formation of thio-salts with alkali sulphides[2]. Kern at first suggested that davyum might occupy the blank space in Mendeléeff's Periodic Table between molybdenum and ruthenium, in which case it should have an atomic weight of about 100; but later, when Alexejeff's preliminary determination indicated a value of about 154[3], it was obvious that davyum could not be eka-manganese, though it might be dvi-manganese.

In the following year, Kern stated[3] that davyum was very rare and that most platinum ores contained no more than 0·0008–0·001 per cent; few contained the amount originally suggested (0·035–0·045 per cent). Little attention was paid to Kern's claim until Mallet[4], in 1898, repeated Kern's work using 15 gm. of residues from 35 kgm. of Russian platinum minerals. This contained insoluble matter (quartz, zircon and osmiridium) and a soluble portion from which a supposed double sodium chloride was prepared. This, on reduction with hydrogen, gave, after removal of alkali chloride, a metal that constituted 37·1 per cent of the salt. Assuming that the substance was a single compound corresponding with the formula Na_2DaCl_6, this would indicate an atomic weight of 151·5, or 165 if the formula was Na_3DaCl_6.

Mallet confirmed the reactions obtained by Kern, and it is interesting to note that they are mainly consistent with those of rhenium. In particular, the thiocyanate reaction and the formation of thiosalts are noteworthy, though the density given by Kern for the metal is less than half that of rhenium, namely, 21·04. But as Mallet pointed out, the whole quantity available was quite inadequate for any exact quantitative analysis.

Noddack and Tacke in 1925, probably unaware of Kern's work, claimed[5] to have found elements 43 and 75 in platinum ores; but their claim has not been substantiated by Russian workers[6], so that the presence of Mendeléeff's dvi-manganese in platinum minerals has even now not been indisputably established. There is, of course, no doubt of the existence of element 75 in Nature; the point is, does it exist in platinum ores? If it does not, then davyum is definitely ruled out. But if it should at some future date be found to occur in platinum minerals, that would go a long way towards substantiating Kern's claim to have discovered a new element.

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[1] Kern, S., *C.R. Acad. Sci., Paris*, **85**, 72 (1877); *Chem. News*, **36**, 4 (1877).
[2] Kern, S., *Chem. News*, **36**, 114 (1877).
[3] Kern, S., *Chem. News*, **37**, 33 (1878).
[4] Mallet, J. W., *Amer. Chem. J.*, **20**, 776 (1898).
[5] Noddack, W., Tacke, I., and Berg, O., *Naturwiss.*, **13**, 567 (1925).
[6] Zvjaginstsev, O., *Nature*, **117**, 262 (1926). Zvjaginstsev, O., Korsunski, M., and Seljakov, N., *Z. angew. Chem.*, **40**, 256 (1927).

Regeneration of the Hypophysial Portal Vessels, after Section of the Hypophysial Stalk, in the Monkey (*Macacus rhesus*)

AFTER section of the hypophysial stalk in the rat, regeneration of the hypophysial portal vessels occurs in the majority of cases[1], and the return of adeno-hypophysial function (as shown by reproductive activity) may be correlated with this vascular regeneration[2]. In order to see if regeneration of these vessels occurred in the Primates, the pituitary stalk was cut by the sub-temporal route in an adult male monkey (*Macacus rhesus*, 12·0 kgm.). Post-operatively, the animal remained in a semi-comatose condition for four days, and then returned to an apparently normal state of health and behaviour. Accurate measurements of the water balance were not made; but there was no obvious polyuria or polydipsia. Masturbation was observed on the tenth post-operative day, and again at about fortnightly intervals until the animal was killed.

On the eighty-ninth day after operation, a lethal dose of nembutal was injected intra-peritoneally and, after deep anæsthesia had been induced, the internal carotid arteries were perfused in a headwards direction with 500 c.c. of Indian-ink solution. After formol fixation and decalcification, serial sections (200 μ thick) were made through a block of tissue containing hypothalamus, pituitary gland and base of skull. Microscopic examination showed the pituitary stalk had been interrupted at the level of the diaphragma sellæ, and that a large mass of fine capillaries and some larger vessels had regenerated and re-established vascular continuity between the median eminence and the adenohypophysis. After formol fixation, the weights of various organs were: testes (both), 24·4 gm.; epididymis (both), 6·0 gm.; seminal vesicles (both), 24·9 gm.; prostate, 4·3 gm.; thyroid, 3·3 gm.; and adrenal glands (both), 1·4 gm. The histological structure of these glands was normal

and they were found to be in an active state, except for the thyroid gland in which the epithelium was found to be flattened.

The conclusions drawn from these observations are:

(1) The lack of an obvious polyuria or polydipsia was due to the fact that the hypophysial stalk was sectioned at the level of the diaphragma sellæ, and that sufficient neurohypophysial tissue remained innervated in the upper part of the stalk to prevent the onset of diabetes insipidus.

(2) Regeneration of the hypophysial portal vessels can occur in Primates in a manner similar to that seen in rats.

(3) The nerve fibres of the hypophysial stalk, which do not regenerate after stalk section, are not essential for normal gonadotrophic and adrenocorticotrophic functions of the anterior pituitary gland. It is unlikely that the quiescent state of the thyroid gland was due to interruption of these nerve fibres; it is probable that the state of this gland may be correlated with the constant, warm environment in which the animal was kept for the eighty-nine days after operation.

(4) Probably the normal spermatogenic and testosterone-secreting activity of the testis and the normal structure of the adrenal cortex, observed after pituitary-stalk section, are to be correlated with the vascular regeneration that occurred between the median eminence and the adenohypophysis.

We wish to thank Dr. A. R. Hunter for advice and help with the anæsthesia.

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Dec. 27.

[1] Harris, G. W., *Nature*, **163**, 70 (1949).
[2] Harris, G. W., *J. Endocrinol*, **6**, xvii (1949).

Distribution of the Littoral Barnacle *Chthamalus stellatus* around the British Isles

The barnacle *Chthamalus stellatus* Poli is found on the shores of the British Isles west of a line running from Dunnet Head (Caithness) to Swanage in Dorset. It penetrates the Irish Sea northwards as far as Dublin and Anglesea, but is reported as absent from the Isle of Man, as well as from the eastern part of the English Channel and from the North Sea coast[1]. Its occurrence appeared to be connected, in some unknown way, with Atlantic as opposed to North Sea water[1]. It is, however, possible to suggest tentatively a simple explanation.

Chthamalus stellatus, although of world-wide distribution[2], is at the northern edge of its range in the British Isles. It is therefore reasonable to expect that its distribution around these shores may be sensitive to low temperature. The limitation of the distribution of marine animals by low temperature, which may either kill them outright or prevent them from breeding, has been discussed by Hutchins[3]. The possibility that the distribution of *Chthamalus stellatus* around the coasts of Britain could be explained in terms of temperature was rejected by Moore and Kitching[1] because of poor agreement with surface-water isotherms. A reconsideration of the conditions under which *Chthamalus* lives in relation to recently published meteorological information has now suggested that the original conclusion may not be justified.

Chthamalus stellatus, being a littoral barnacle, must endure not only the variation of temperature of the coastal water but also the much greater extremes imposed on it during exposure to air. A study of meteorological records and charts, supplemented with data kindly supplied by the Director of the Meteorological Office and by the Director of the Irish Meteorological Office, has shown that a reasonably satisfactory correlation between temperature and the distribution of *Chthamalus stellatus* occurs during the winter months. Both the February surface-water isotherm[4] for 7° C. and the February mean daily minimum air temperature isotherm[5] for 38° F. (3·3° C.) follow fairly closely the limit of distribution of *Chthamalus stellatus* on the coasts of England, Wales, Ireland and northern France, but not on the west coast of Scotland, where *Chthamalus* apparently persists in spite of low temperature. The 15° F. (− 9·4° C.) isotherm[6] of the absolute minimum air temperature recorded over the period 1901–40 also shows a striking concurrence with the limit of *Chthamalus stellatus* in all parts of the British Isles except the north-west of Scotland. It was this discrepancy which led Moore and Kitching to reject temperature as a controlling factor.

Meteorological records for north-west Scotland are derived from a very small number of stations, mostly inland or at high altitude, and so unsuitable for the purpose under consideration. There are no stations between Cape Wrath and Wick. Moreover, local variation between close and apparently similar situations may be considerable. Conditions at coastal meteorological stations can only give a relative idea of those on the shore, and then only where stations are plentiful. Present meteorological records are therefore consistent with the hypothesis proposed, subject to the reservation that not enough is known about conditions in the west and north of Scotland.

Limitation by low temperature (as a predominant factor) provides a working hypothesis which is simpler and easier to test than the 'Atlantic water' theory, although from the known facts the latter is equally possible. There is one difficulty: towards its northern limit *Chthamalus* becomes restricted to a narrow zone at the upper margin of the littoral region; one might have expected it to survive better at lower levels, where it would be less exposed to cold air.

Considerations of this sort suggest that experiments might be carried out on the ability of *Chthamalus* to withstand cold under conditions representative of those at the upper and lower levels of the shore. Not until simple and direct explanations have been excluded will it be necessary to invoke the more complicated and inaccessible influence of 'Atlantic water'.

I am glad to acknowledge discussions of this question with Dr. H. B. Moore and Dr. D. J. Crisp.

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Jan. 18.

[1] Moore and Kitching, *J. Mar. Biol. Assoc.*, **23**, 521 (1939).
[2] Darwin, "A Monograph of the Cirripedia" (1853).
[3] Hutchins, *Ecol. Mon.*, **17**, 325 (1947).
[4] Deutschen Seewarte Hamburg, Atlas für Temperatur, Salzgehalt und Dichte der Nordsee und Ostsee (1927).
[5] Air Ministry, Meteorological Office. Monthly and Annual Maps of Average Temperature over the British Isles (1943).
[6] Air Ministry, Meteorological Office. Variation of Temperature over the British Isles (1944).

Examination of the Magnesian Sandstone Beds of the Punjab Salt Range for Plant Micro-fossils

THIS note deals with the micro-fossil investigation of a sample of magnesian sandstone carried on at the instance of Prof. B. Sahni (then on tour in the United States) in 1948. The work was done with the view of checking the results quoted by Ghosh, Sen and Bose[1] referring to the recovery of carbonized pieces of wood with uni- to multi-seriate bordered pits from Magnesian Sandstone Sample 6292 collected from the eastern part of the Salt Range.

Material. Sample 84 : a large slab of magnesian sandstone, with fuccoid markings, collected by the Geology Department, University of Lucknow, from Circuit House Hill, Khewra Gorge, Salt Range, Punjab. The rock is dull grey in colour, coarse grained, compact and hard.

Technique. The rock sample did not show any cracks or crevices. Small bits of rock were broken from inside, ground and polished to avoid any foreign body sticking to the surface. These pieces, which usually weighed about 6 gm. for each maceration, were exposed to a spirit lamp flame for half a minute and put in a clean maceration jar. About 20 c.c. of 4 per cent hydrochloric acid (filtered) was added, and the jar kept under a bell jar. After a few days, when the rock was completely broken down, the remaining acid was centrifuged out and the macerated material was further washed with filtered distilled water to eliminate all traces of the acid. This residue was then treated with ammonia for a day. The alkali was later eliminated by washing and the material stained with a drop of Safranin. Excess of Safranin was removed by repeated centrifuging. Finally the residue was spread out in smears on a number of clean slides under a glass cover. When the smear was dry, the slides were mounted in Canada balsam.

An exactly similar procedure was adopted for maceration with hydrofluoric acid. The maceration was done in a platinum crucible. The excess of acid was neutralized by a concentrated solution of boric acid (note by Sud, see B. Sahni[2]).

Every possible chance of external contamination during maceration was avoided. All the glass apparatus used was thoroughly cleaned by a concentrated solution of chromic acid (potassium dichromate + sulphuric acid) and afterwards washed with distilled water. All the reagents used were filtered and stored in clean dust-proof bottles inside a glass cabinet. Each slide and coverslip was dipped in alcohol and burnt before use. Staining with Safranin was done to distinguish all unstained contaminated plant matter in temporary and permanent preparations from the stained micro-fossils of the rock. Before staining, the technique required great care to avoid any introduction of external plant material. Occasionally a few dark grey or charred pieces of material resembling carbonized pieces of organic fibres or tracheids may be found sticking to the slides, due to imperfect cleaning of slides and coverslips. Original micro-fossils, on being treated with acid and alkali, become lighter in colour and are also stained with Safranin.

In all, more than fifty permanent preparations and a number of smear slides were examined; but no micro-fossils were recovered. The results are negative and do not show any evidence of a post-Cambrian age for these rocks.

Discussion. At the outset, it is necessary to consider the implications of the investigations of Ghosh[3] and others[4]. In the Salt Range, a set of four conformable Cambrian rocks lie over the Saline Series, namely, purple sandstone, *Neobolus* shale, magnesian sandstone and salt-pseudomorph shales. *Neobolus* shale, over which magnesian sandstone lies in perfect conformity, is of Cambrian age by virtue of the presence of *Neobolus* shells in the rock, and in magnesian sandstone is found *Stenotheca*, a mollusc of lower Cambrian age. There is no record of the existence of land plants during the Cambrian age. These rocks should therefore be completely devoid of micro-fossils of the nature of pieces of wood or spores of land plants. Careful researches by Hsü[5] on the purple sandstone, and by Sahni, Lakhanpal and Bhardwaj on beds of salt pseudomorphs[6], have revealed a complete absence of any tertiary fossils in them. Ghosh and others, however, have recovered tertiary plant micro-fossils from all the beds of Cambrian series, including *Neobolus* shale. This makes it difficult to reconcile our findings with their work. The only explanation of their find of tertiary plant remains in these rocks of a Cambrian sequence would seem to be contamination during investigation, or the use of cracked and fissured samples.

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Lucknow.
July 20.

[1] Ghosh, A. K., Sen, J., and Bose, A., Abs. Geol. Soc. 35th Ind. Sci. Cong. (1948).
[2] Sahni, B., *Proc. Nat. Acad. Sci. Ind.*, **16** (2–4), I-L (1946).
[3] Ghosh, A. K., and Bose, A., *Nature*, **160**, 796 (1947).
[4] Gee, E. R., Symposium I, *Proc. Nat. Acad. Sci. Ind.*, **14**, (64), 269 (1944); **16**, (2–4), 95 (1946).
[5] Hsü, J., *Proc. Nat. Acad. Sci. Ind.*, **16**, (2–4), 92 (1946).
[6] Sahni, B., Lakhanpal, R. N., and Bhardwaj, D. C., "Are the Salt Pseudomorph Beds in the Salt Range of Tertiary Age?" (in the press).

"Velocity of Light and of Radio Waves"

I SHOULD like to direct attention to the fact that in my article on the velocity of light and of radio waves[1] the result announced by Houstoun[2] was unfortunately omitted. It had not been published when my article was prepared, but could have been inserted had I noticed it in time. I was able to insert the still more recent value obtained by Bergstrand because it happened to be in the press at the same time as my article and the Editors brought it to my notice.

Houstoun's result is important because it is in close agreement with the commonly accepted value of 299,776 km./s. and not with the other recent values obtained by both radio and optical methods, which are all very near 299,792 km./s. and are believed to have limits of error not exceeding ± 3 km./s.

It emphasizes that the present position cannot be regarded with any complacency, and a still more accurate measurement is needed to establish the value to the nearest kilometre beyond any reasonable doubt.

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May 1.

[1] Essen, *Nature*, **165**, 582 (1950).
[2] Houstoun, *Nature*, **164**, 1004 (1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 22

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Dr. E. B. Worthington: "Recent Geographical Developments in East Africa".

Tuesday, May 23

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, BIOLOGICAL METHODS GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 2.15 p.m.—Symposium on "The Assay of Vitamin B_{12}".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Prof. Monica Wilson: "The Nyakusa Age-Villages".

UNIVERSITY OF LONDON (at Bedford College for Women, Regent's Park, London, N.W.1), at 5.15 p.m.—Dr. Joseph Needham, F.R.S.: "Human Law and the Laws of Nature in China and the West" (Hobhouse Memorial Lecture).*

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. C. K. Ensor: "Quantity and Quality in the Population of Great Britain".*

UNIVERSITY OF LONDON (in the Chemistry Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Kathleen Lonsdale, F.R.S.: "Facts and Fancies about Crystals" (Inaugural Lecture).*

Wednesday, May 24

ROYAL SOCIETY OF MEDICINE, ENDOCRINOLOGY SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Annual General Meeting; Prof. H. M. Evans (University of California): "Growth Hormone".

BRITISH PSYCHOLOGICAL SOCIETY (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 8 p.m.—Symposium on "The Teaching of Psychology to Medical Students".

Thursday, May 25

UNIVERSITY OF LONDON (at Birkbeck College, Bream's Buildings, Fetter Lane, London, E.C.4), at 5.30 p.m.—Dr. R. Emerson (University of California): "The Aquatic Phycomycetes in Experimental Biology".* (Further Lectures on Tuesday, May 30, and Thursday, June 1, at King's College, Strand, London, W.C.2.)

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Sir Richard Fairey: Thirty-eighth Wilbur Wright Memorial Lecture.

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. E. G. Hamer and Mr. W. P. Cole: "Multi Station V.H.F. Communication Systems using Frequency Modulation".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD OF THE TELECOMMUNICATIONS ENGINEERING AND PHYSICS DEPARTMENT—The Principal, Norwood Technical College, Knight's Hill, London, S.E.27 (May 27).

PRODUCTION MANAGER (unestablished) at a Royal Ordnance Factory in Lancashire to be responsible, under the Superintendent, for the organisation and direction of large factory units engaged in filling all types and calibres of ammunition and analogous stores—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.276/50A (May 27).

OBSERVER IN THE DEPARTMENT OF ASTRONOMY, and a LECTURER IN BIOCHEMISTRY in the Department of Physiology of United College—The Secretary, The University, St. Andrews (May 30).

TECHNICAL ASSISTANT (with a science degree in biochemistry and/or physiology) to the Advisory Officer in Animal Husbandry—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (May 30).

ASSISTANT LECTURER IN ZOOLOGY—The Registrar, University College, Cathays Park, Cardiff (May 31).

CHAIR OF PHYSICS at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

LECTURER/ASSISTANT LECTURER IN AGRICULTURE (Crop Husbandry)—The Registrar, University College of Wales, Aberystwyth (May 31).

PRINCIPAL—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (May 31).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in engineering or an equivalent qualification), and a SENIOR SCIENTIFIC OFFICER or PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or engineering or an equivalent qualification), in the Royal Naval Scientific Service—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3082 (May 31).

RESEARCH BOTANIST with honours degree, for research on certain aspects of frost damage to fruit trees, and to engage in pomological work, an ANALYTICAL CHEMIST in the Plant Protective Chemistry Section, a RESEARCH BOTANIST (male, with a good honours degree and a sound grounding in plant physiology) in the Physiology Section for work on the physiology of fruit trees including problems of stock–scion effects, and an ENTOMOLOGIST (with a bias towards research in insect physiology) to be attached to the Plant Protective Chemistry Section for investigations on the mode of action and bio-assay of insecticides—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (May 31).

ZOOLOGIST (man or woman) with ecological interests, for research on the ecology of streams, rivers or lakes—The Director, Freshwater Biological Association, Wray Castle, Ambleside, Westmorland (May 31).

SENIOR SCIENTIFIC OFFICER in the Commonwealth of Australia Department of Supply, to undertake theoretical investigations of the performance to be expected of various contemplated types of defence equipment, and to direct a team doing similar work—The Senior Representative, Department of Supply and Development, Canberra House, 85–87 Jermyn Street, London, S.W.1 (June 1).

LECTURER IN BOTANY—The Registrar, The University, Manchester 13 (June 3).

UNIVERSITY LECTURER IN MATHEMATICS (with special qualifications in mathematical analysis), and a UNIVERSITY LECTURER IN MATHEMATICS (with special qualifications in some branch of applied mathematics)—Dr. A. J. Ward, Emmanuel College, Cambridge (June 3).

LECTURER to take charge of the High Voltage Laboratories, and ASSISTANT LECTURERS (2, one to assist in the Electronics Laboratory and the other in the Electrical Machines Laboratories), in the Department of Electrical Engineering—The Registrar, The University, Manchester 13 (June 9).

LECTURER IN SCHOLASTIC PHILOSOPHY—The Secretary, Queen's University, Belfast (June 10).

GRADUATE (Experimental Officer grade) for soil analysis with the Soil Survey of England and Wales—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (June 12).

LECTURER IN MATHEMATICS in the United College—The Secretary, The University, St. Andrews (June 15).

SCIENTISTS (Grade III), with a good honours degree in chemistry, in the Board's Coal Survey Laboratories at Birmingham, Sheffield, Leeds, Nottingham and Chester—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting T7/217 (June 16).

ASSOCIATE PROFESSOR OF MINING ENGINEERING at the Broken Hill Technical College, New South Wales—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (June 26).

CHAIR OF MECHANICAL ENGINEERING, the CHAIR OF CIVIL ENGINEERING, and the NUFFIELD RESEARCH CHAIR OF MECHANICAL ENGINEERING at the New South Wales University of Technology—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (June 26).

LECTURER or SENIOR LECTURER IN GEOLOGY at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, June 30).

RESEARCH OFFICER IN THE MICROBIOLOGICAL CHEMISTRY DIVISION of the National Chemical Research Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, June 30).

LECTURER IN CLINICAL PSYCHIATRY—The Registrar, The University, Manchester 13 (July 17).

ASSISTANT EXPERIMENTAL OFFICER IN THE BACTERIOLOGY DEPARTMENT, to participate in field and laboratory studies of bovine mastitis—The Secretary, National Institute for Research in Dairying, Shinfield, Reading.

CHIEF ELECTRICAL ENGINEER in the Public Works Department, Aden—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27326/30.

DEVELOPMENT GROUP MANAGER to take charge of a Physics Research and Development Group involving metrology, kinetic theory, properties of matter, fluid dynamics, heat, mass spectrometry, and high vacuum technique, an ASSISTANT GROUP MANAGER to undertake mathematical research into atomic energy problems, and a WORKS PHYSICIST to undertake the duties outlined in Post 1, at the Division of Atomic Energy Factory, Capenhurst, Chester—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

GRADUATE IN CHEMISTRY, PHYSICS or CHEMICAL ENGINEERING, to carry out a programme of research concerning the combustion of hydrocarbons—The Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7.

LECTURER IN BOTANY up to B.Sc. Special standard—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

LECTURER IN THE DEPARTMENT OF CHEMISTRY AND APPLIED CHEMISTRY—The Principal, Royal Technical College, Salford 5.

PASTURE RESEARCH OFFICER (with a University degree in agriculture or botany and some experience in grassland husbandry research) in the Sudan Veterinary Service—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Pasture Research'.

PHYSICIST for work on physical properties of powders and suspensions, and methods of processing such materials—The Director of Research, Research Council of the British Whiting Federation, 245 Ampthill Road, Bedford.

RESEARCH FELLOWSHIPS (2, one in the field of Micro-Wave Spectroscopy, and the other in Infra-Red Spectroscopy)—Dr. G. M. Shrum, Head of the Department of Physics, University of British Columbia, Vancouver, B.C., Canada.

RESEARCH OFFICER (temporary) AT THE OIL PALM RESEARCH STATION, Benin, Nigeria—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

SENIOR LECTURER IN AIRCRAFT STRUCTURE TESTING—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks.

SENIOR LECTURER IN ELECTRONICS, a LECTURER (with particular interest and experience in light current subjects) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, and ASSISTANT LECTURERS IN THE DEPARTMENT OF CHEMISTRY—The Secretary, Royal Technical College, Glasgow.

WORKS CHEMISTS (*a*) to undertake supervisory duties in connexion with the operation of large chemical plants, (*b*) to undertake chemical research and development work involving fluorine chemistry, corrosion problems, material testing, and the use of elastomers and high polymers, at the Division of Atomic Energy Springfields Factory, Salwick, Preston, and at Windscale Works, Sellafield, Cumberland—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.